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THE RELATIONSHIP OF TEMPERATURE AND DISSOLVED OXYGEN TO THE SEASONAL SETTLEMENT OF THE POLYCHAETOUS ANNELID *HYDROIDES NORVEGICA* (GUNNERUS)[1]

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INTRODUCTION

Hydroides norvegica (Gunnerus) is a serpulid polychaete that is widely distributed in the warmer temperate seas of the world. It constructs white calcareous tubes (Plate 1, Fig. 2 and 4) which are found attached to pilings, docks, hulls of ships, as well as other sedentary organisms or solid substrates.

While pursuing other biological studies in Los Angeles — Long Beach Harbors in 1950-1955 the author observed that *H. norvegica* appeared to have a seasonal period of settlement. Furthermore, there seemed to be a greater amount of settling some years than in others. It was not possible until 1956 to establish a study to determine the validity of these previous observations. This paper constitutes the results of observations made from 1956 through 1958.

Seasonal settlement of fouling organisms in the Pacific Ocean have been studied at Friday Harbor, Washington (Johnson and Miller, 1935), in California at Oakland estuary (Graham and Gay, 1945), Los Angeles — Long Beach Harbors (Barnard, 1958), Newport Bay (Scheer, 1945), La Jolla (Coe and Allen, 1937), San Diego Bay (Wheldon, 1937, in Anon, 1952), and at Kaneoke Bay, Oahu, Hawaii (Edmondson and Ingram, 1939). *Hydroides norvegica* was reported only from Los Angeles — Long Beach Harbors and Kaneoke Bay. Additional seasonal studies have been made in Japan south to Australia (see Anon, 1952), but *H. norvegica* was not present. Settlement of *H. norvegica* occurred throughout the year at Kaneoke Bay where the water temperatures were never below 22°C. The relationship of water temperature to seasonal settlement of *H. norvegica* in Los Angeles — Long Beach Harbors was not discussed by Barnard (1958).

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Periodicity in settling has been studied in Sydney, Australia, by Dew and Wood (1955) and Wisely (1958). It was found that *H. norvegica* settled on test panels during each month of the year with peaks occurring in December and April (Wisely, 1958). Peaks of settling coincided with the spring tides from October to March (Dew and Wood, 1955).

MATERIALS AND METHODS

Douglas fir wood blocks, measuring 6 X 1.5 X 1.5 inches, were suspended for 28 day periods at the 15 foot water depth at eight stations in Los Angeles — Long Beach Harbors (Plate 1). The 28-day period was selected since it divided the year into 13 periods of equal time. The study commenced at some of the stations

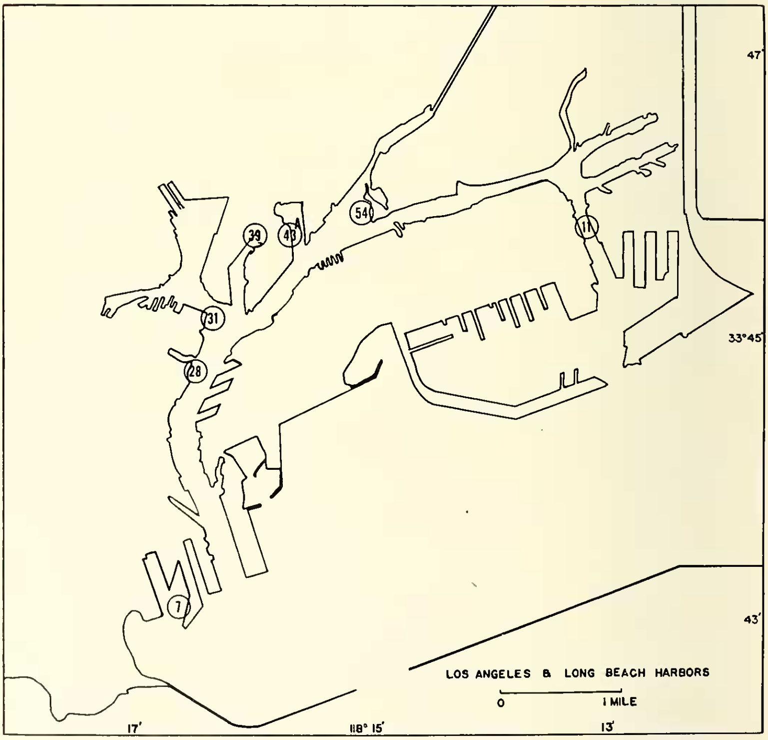
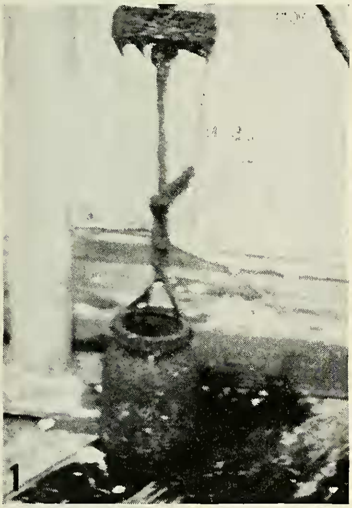


PLATE 1

Los Angeles-Long Beach Harbors, California, showing station locations where test blocks were suspended. Station 11 is in Long Beach Harbor; the remaining stations are in Los Angeles Harbor.



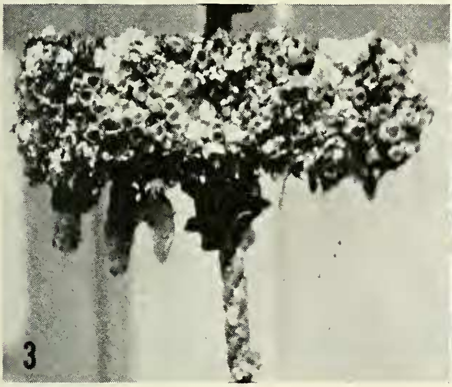


PLATE 2

Figure 1. Test block and gallon jar suspended at LA 31 for 28-day period ending May 7, 1958. Principle organisms are *Balanus* sp. and *Obelia* sp.

Figure 2. Same test block and bottle as in figure 1 exposed for 56-day interval ending June 4, 1958. *Hydroides norvegica* and *Tubularia* sp. are principle animals.

Figure 3. Same test block as in previous two figures exposed for 84 days ending July 3, 1958. *Ciona intestinalis* and dead *Balanus* sp. constitute the majority of the attached organisms.

Figure 4. Test block suspended at LA 28 for 28-day period ending July 30, 1959, during heavy settlement of *Hydroides norvegica.*

December 21, 1955 (with the first period extending until January 18, 1956, this constituting the first month in 1956). At some stations the study was terminated at the end of 1957, at others near the end of 1958.

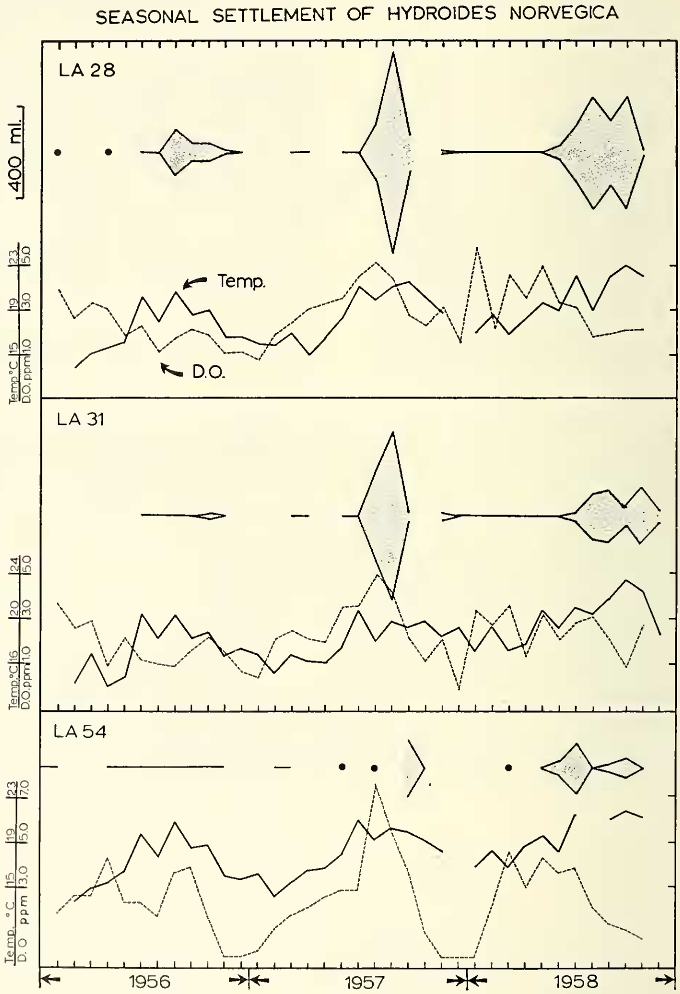


PLATE 3

Seasonal settlement of *H. norvegica* in relation to temperature and dissolved oxygen during 1956-1958 at stations LA 28, LA 31, and LA 54. The scale for the volume of *H. norvegica* is indicated in the upper left margin. Black dots indicate *H. norvegica* was present in a small amount

The wood blocks were picked up and replaced with a new one each 28-day period. Photographs were made of many of the blocks (Plate 2, Figs. 1-4). At the same time the temperature of the water at the 15 foot depth was determined. Dissolved oxygen was measured at the same depth utilizing the modified Winkler method. Chlorinity was not determined since it was known to be that of normal sea water and to vary little (Reish, 1959).

The wood blocks were brought to the laboratory; the specimens were scraped from the test blocks and preserved in formaldehyde. The samples were analyzed and the volume occupied by each dominant species determined. While there were many other species of animals observed on these blocks, only the seasonal settlement of *Hydroides norvegica* is discussed herein.

The seven stations (Plate 1) were selected from various ecological areas of Los Angeles — Long Beach Harbors. The station numbers employed are those used in previous studies in these harbors (Anon, 1952; Reish, 1955; 1959). The stations located in Los Angeles Harbor are indicated by "LA"; and the one station in Long Beach Harbor by "LB." These stations may be briefly located and characterized as follows. Since the amount of dissolved oxygen present in the water mass in harbors is frequently dependent on the degree of pollution, these data are included.

LA 7	Berth 42, Los Angeles outer harbor, Watchhorn Basin. Pollution was not serious in the vicinity of this station, wastes include small amounts of discharges from oil well operations, cooling waters, and domestic sewage.
LA 28	Berth 92, Los Angeles Harbor main channel. The area was influenced by the large amounts of oil refinery wastes emptied into the West Basin.
LA 31	Berth 99, at the entrance of West Basin, Los Angeles Harbor. Waste discharge as station LA 28.
LA 39	Berth 162, at Los Angeles Harbor Department docks. No major contributors of waste discharges are in the vicinity; however, the station is located at the end of slip and water circulation is limited.

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but was not the previous or following times. Horizontal lines indicate *H. norvegica* present at least for two successive collections but never abundantly. Blank spaces indicate that *H. norvegica* was either not present (usually the case) or the test panel was lost (rare).

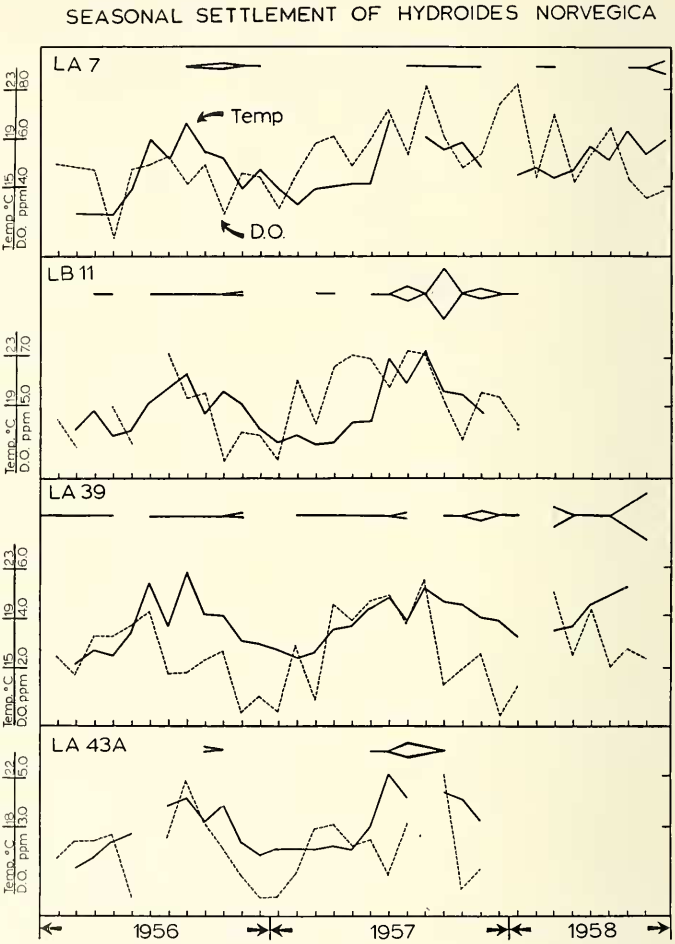

PLATE 4

Seasonal settlement of H. norvegica in relation to temperature and dissolved oxygen during 1956-1958 at stations LA 7, LB 11, LA 39, and LA 43 A. Scale for volume of *H. norvegica* and additional explanations as in Plate 3.

LA 43A	Berth 179 is Slip 5 region of Los Angeles Harbor. Fish cannery wastes and vegetable oil plant wastes are discharged in the vicinity.
LA 54	East Basin, opposite Berth 203 in Los Angeles Harbor. Large quantities of oil refinery wastes emptied into the Consolidated Slip influenced this station (Reish, 1957).
LB 11	Pontoon bridge in Long Beach Harbor. Pollution was not serious in this area.

RESULTS

The data are summarized in Plates 3 and 4. The seasonal settlement and volume of *H. norvegica* are indicated for each station along with the water temperature and amount of dissolved oxygen.

It can be seen from Plates 3 and 4 that there is a considerable amount of variation in the amount of settling, during a year, during different years, and from station to station. Settlement was greatest at all stations, except at LA 7, during 1957 and 1958. Only at station LA 28 did moderately heavy growths of *H. norvegica* occur in 1956. Water temperateures were high in 1957-8 and low in 1956. Peaks in settling coincided within the same seasonal period at all stations. The range of time within a year was more extensive at some stations than at other stations. The maximum settlement occurred during months 8 to 10, or from early July through late September, which corresponded to the times of the highest water temperatures. Little or no settlement occurred during the winter months.

Tables 1 and 2 summarize the water temperature and dissolved oxygen data for each station according to whether or not *H. norvegica* was collected and for those stations at which the volume exceeded 100 ml. The ranges and averages are included for each category for each station. While there were some overlaps in temperature, in general the data show that *H. norvegica* does not settle when the temperature is low. The warmer the water temperature the more likely that *H. norvegica* will be present, and if the water temperatures are high, the greater the possibility that a large quantity will settle.

The lowest temperature recorded at which *H. norvegica* was present was 15.0° C; the lowest temperature measured at which there was a large settlement of the serpulid was 18.4°C. *Hydroides norvegica* was present in all instances when the temperature was above 20.0°C. There were three instances in which the temperature was at 20.0°C but no *H. norvegica* was present on the test block. Two of these occurred on October 23, 1957, at LA 28 and LA 31 when the dissolved oxygen was low. The other was at LA 43A on

Table 1

Relationship between Settlement of *Hydroides norvegica* and Water Temperature (°C)

Station	*H. norvegica* absent		*H. norvegica* present		Volume of *H. norvegica* 100 ml. +	
	Range	Average	Range	Average	Range	Average
LA 28	13.8-20.0	16.2	15.0-23.0	18.9	19.8-23.0	21.1
LA 31	14.5-20.0	16.4	16.5-23.8	19.4	18.4-22.8	20.5
LA 54	14.0-18.9	16.8	15.5-22.2	18.8	20.2-21.8	21.0
LA 7	13.0-19.0	15.6	15.0-20.4	18.2		
LB 11	16.5-17.5	17.0	15.9-23.0	18.8		
LA 39	16.0-17.5	16.7	15.0-22.3	18.4		
LA 43A	14.5-20.0	16.5	18.3-22.0	19.8		
Summary	13.0-20.6	16.4	15.0-23.8	19.0	18.4-23.0	20.9

Table 2

Relationship between Settlement of *Hydroides norvegica* and Dissolved Oxygen (ppm)

Station	*H. norvegica* absent		*H. norvegica* present		Volume of *H. norvegica* 100 ml. +	
	Range	Average	Range	Average	Range	Average
LA 28	0.7-3.3	2.0	1.1-5.7	3.2	1.8-5.1	2.9
LA 31	0.5-3.8	2.1	0.0-5.0	2.4	2.3-5.0	3.7
LA 54	0.0-3.1	1.5	0.0-4.5	2.4	3.8-4.0	3.9
LA 7	2.0-8.2	5.4	3.0-8.2	4.9		
LB 11	3.2-7.0	4.6	2.7-7.3	5.1		
LA 39	0.0-3.5	1.4	0.0-5.4	2.7		
LA 43A	0.0-4.7	1.6	0.9-5.0	2.7		
Summary	0.0-8.2	2.9	0.0-8.2	3.2	1.8-5.1	3.3

August 22, 1956; there was adequate oxygen present in the water at this time.

The relationship between the amount of dissolved oxygen present and the settlement of *H. norvegica* is not as well defined as it was for water temperature (Table 2). Maximum readings may be encountered nearly any month of the year. Minimal amounts generally occurred during December and January (Plates 3 and 4). In most cases, the greater the concentration of dissolved oxygen at a station the more likely that *H. norvegica* will be collected, and at stations LA 28, 31, and 54, the more likelihood of larger volumes. High dissolved oxygen values were measured the majority of the time at LA 7 and LB 11 and because of this, this factor is probably of minor importance as a limiting factor at these stations.

In general, there are probably two factors that play a role in attaining heavy settlement of this serpulid polychaete. Warmer water temperatures and adequate oxygen supply over a long period of time probably result in a faster rate of maturity and greater amount of spawning over a longer period of time. Lower amounts of dissolved oxygen and lower temperatures in the late months probably play a major role in the reduction in settling.

SUCCESSION

If growth of *H. norvegica* is rapid and the block is allowed to remain in the water for a period of time greater than one month, some indication of succession is noted. Plate 2, figures 1-3 represent such a change. In figure 1, the test block had been exposed for 28 days. Principle organisms include *Balanus sp.* and *Obelia* sp. Figure 2 shows the same block at 56 days. The block, line, and bottle are covered with an extensive growth of *H. norvegica.* A small quantity of the hydroid *Turbellaria* sp. is present on the lower surface of the block and on the bottle. By 84 days, no *H. norvegica* were present (Fig. 3). The weight of the tube mass had become too large and *H. norvegica* had fallen off. The majority of the animals on the block consisted of empty *Balanus* sp. shells, apparently these were killed by the growth of the polychaete. A few specimens of *Ciona intestinalis* were present at this time.

ASSOCIATED ORGANISMS

Generally there are about ten different animal species associated with the extensive growths of *H. norvegica* (Plate 2, fig. 2). Chief among these are the tube building amphipod *Corophium acherusicum* (Costa), the tube building polychaete *Polydora* (*C.*) *paucibranchiata* Okuda, the bryozoan *Bugula neritina,* Linnaetus), the solitary tunicate *Ciona intestinalis* (Linnaeus), and the barnacle *Balanus* sp. Free living species found among the tubes include the polychaetes *Capitella capitata* (Fabricius), *Platynereis bicanaliculata* (Baird), *Halosydna johnsoni* (Darboux), and *Podarke pugettensis* Johnson, and the crustacean *Epinebalia* sp.

The attached organisms, including *H. norvegica,* feed on particulate matter present in the water mass. The waters in the harbors are very turbid and can support a high population of suspension feeders (Barnard, 1958). The free-living organism feed largely upon debris within the association; although *Halosydna johnsoni* and *Podarke pugettensis* are known to feed upon crustaceans and diatoms (Reish, 1954).

While it was stated that the other major sessile organisms attaching on the wood blocks is not the subject of this paper, a few remarks concerning these animals are worthy of mention. The tunicate *Ciona intestinalis* was particularly abundant in the late spring to early summer months at LA 5 and LA 28. An unidentified species of *Obelia* sp. was taken in the winter and spring months at LA 31, in the spring at LA 28, and sporadically at LA 7 and LA 43A. *Bugula neritina* appeared at various times at LA 43A and LA 54. *Corophium archerusicum* built extensive mud tubes on the panels at LA 7 and LB 11, generally in spring. *Polydora paucibranchiata* was present sporadically at LA 39.

SUMMARY

1. The seasonal settlement of the calcarious tube-building polychaetous annelid *Hydroides norvegica* was studied from 1956 through 1958 at seven stations in Los Angeles-Long Beach Harbors.
2. Large populations of *H. norvegica* settled on wood test panels at some stations during 1957 and 1958. This was found to be related to warmer water temperatures.
3. Settlement occurred in all instances when the water temperature was above 20°C. Large growths of *H. norvegica* occurred at temperatures above 18.4°C. No animals attached to test panels at water temperatures below 15.0°C.
4. In most instances, heavier settlement of the polychaete occurred at stations having greater concentrations of dissolved oxygen.
5. The succession of the *H. norvegica* population, the associated organisms, and the other principle fouling organisms in Los Angeles-Long Beach Harbors are discussed.

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A NEW SPECIES OF SILIQUA (PELECYPODA) FROM WESTERN NORTH AMERICA

By LEO G. HERTLEIN

During the course of dredging off the coasts of California and Alaska, specimens of a *Siliqua* were obtained by Dr. G. Dallas Hanna which did not seem referable to either *S. lucida* or to the young of *S. patula*. The coloration of the shell, together with the fact that their habitat was in moderately deep water in comparison to the coast-inhabiting *Siliqua patula* and *S. lucida*, suggested that they represented a distinct form. Such proves to be the case and it is here described as a new species.

The genus *Siliqua* has been reported in California in strata of late Cretaceous[1] age, and from late Miocene to Recent. A synopsis of the Recent species of North America and the Antilles was published by Dall[2].

The writer wishes to acknowledge the assistance and advice given by Dr. G. Dallas Hanna, Curator of the Department of Geology, California Academy of Sciences, and Mr. A. G. Smith, Research Malacologist in the same institution. Dr. I. McT. Cowan, Department of Zoology, University of British Columbia, furnished specimens and information concerning their occurrence in British Columbia. Photographs used in the present paper were prepared by the late Frank L. Rogers.

Key to the Recent West American species of SILIQUA.

A. Internal radial rib sloping anteriorly .... *patula*
B. Internal radial rib sloping nearly vertically
    a. Adult shell large, high, thick, usually exceeding 40 mm. in length .... *alta*
    aa. Adult shell, small, very elongate, thin, usually not exceeding 40 mm. in length
        b. Posterior end squarish .... *lucida*
        bb. Posterior end elliptical .... *sloati*

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(1) *Siliqua alisoensis* Packard, Univ. Calif. Publ., Bull. Dept. Geol. Sci., Vol. 13, No. 10, p. 427, pl. 34, fig. 2, June 30, 1922. "Chico group, *Tellina ooides* zone," late Cretaceous, in Santa Ana Mountains, Southern California.

(2) See Dall, W. H., "Synopsis of the Solenidae of North America and the Antilles," Proc. U. S. Nat. Mus., Vol. 22, No. 1185, pp. 107-122, October 9, 1899 (*Siliqua*, p. 109.).

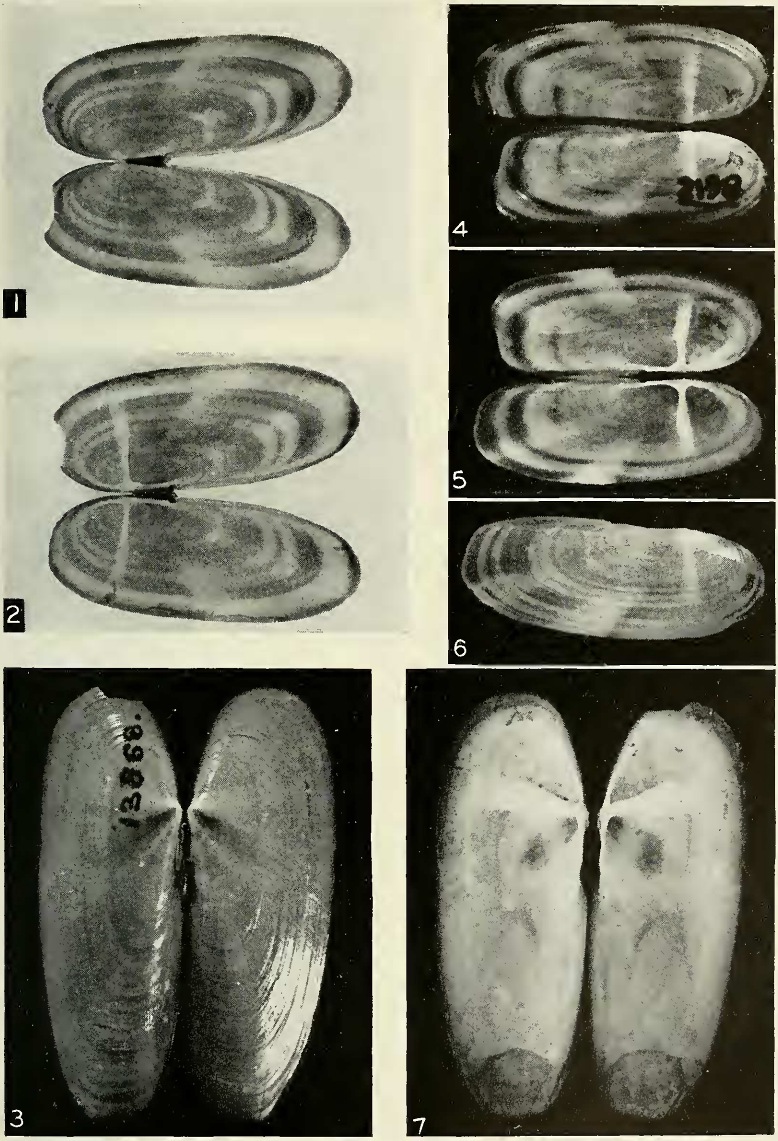

PLATE 5

Explanation of Figures

Figs. 1, 2. *Siliqua sloati* Hertlein, new species. Holotype, from off Laguna Point, Mendocino County, California; length, 35 mm. 1. View of exterior. 2. View of interior. Figs. 3, 7. *Siliqua patula* Dixon. From Morro Bay, San Luis Obispo County, California; length, 46 mm. 3. View of exterior. 7. View of interior. Figs. 4, 5, 6. *Siliqua lucida* Conrad. From breakwater at North Island, Los Angeles County, California. 4. View of exterior; length, 30.9 mm. 5. View of interior of same specimen. 6. View of exterior of a right valve; length, 32 mm.

Siliqua sloati Hertlein, new species
Plate 5, Figs. 1, 2; Plate 6, Figs. 4-7

Shell elongately oval, thin; beaks situated at about one-fifth the length from the anterior end which is ovally rounded; posterior to the beaks the shell gradually curves toward the posterior end which is rather acutely rounded; exteriorly the shell is beautifully polished and ornamented by concentric oval brownish bands on a cream colored background; interior as in *Siliqua lucida* with the internal rib sloping nearly vertically to the ventral margin. Length, 35 mm., height, 12.2 mm., convexity (both valves together), approximately 5 mm.

Holotype (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 31156 (C.A.S.), 356° 2.8 miles off Laguna Point, Mendocino County, California, dredged in 46 to 49 meters (25½-27 fathoms); G. Dallas Hanna, collector, August 6, 1940. Paratypes (Calif. Acad. Sci. Paleo. Type Coll.), from Loc. 28545 (C.A.S.), at point where line W. ¾ S. from Pt. Bonita, California, crosses the 55 meter (30 fathom) line; G. H. Clark and G. D. Hanna, colls., April 29, 1936.

Additional specimens, the largest 40 mm. long, were dredged in northern California. Dr. I. McT. Cowan presented two specimens which were dredged in 18 meters (10 fathoms) in Plumper Sound, Saturna Island, British Columbia. He also mentioned (written communication) that this species was dredged in Georgia Strait, British Columbia, in 22-82 meters (12 to 45 fathoms) on a muddy bottom. One specimen was dredged by Dr. G. D. Hanna in Portage Bay, Alaska, in 31 meters (17 fathoms).

Range: Portage Bay, Alaska, to Point Bonita, Marin County, California, in 18 to 157 meters (10 to 86 fathoms).

This new species differs from *Siliqua lucida* Conrad[3] in that the posterior end is more pointed, the posterior dorsal area is less expanded, more curved and not bordered by a distinct groove, and the exterior of the shell is highly polished and ornamented by bright colored bands of brown and cream in comparison to the subdued brownish and purplish color of S. *lucida.*

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(3) *S[olecurtus]. lucidus* Conrad, Jour. Acad. Nat. Sci. Philadelphia, Vol. 7, p. 231, pl. 17, fig. 8, 1837. "*Inhabits* the sand beach, near Sta. Barbara, uncommon." Also illustrated by I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci., Vol. 1, p. 189, pl. 52, fig. 2, 1924 (as *Siliqua lucida*). Monterey, California, to Todos Santos Bay, Lower California. Also in the Pleistocene at San Pedro and San Diego, California — Grant and Gale, Mem. San Diego Soc. Nat. Hist., Vol. 1, p. 389, pl. 21, fig. 6, 1931 (as *Siliqua lucida*). Earlier records cited. Pliocene to Recent.

Compared to the young of *Siliqua patula* Dixon[4] the new species is less elongate, the beaks are more anteriorly situated. It also differs in the decided color banding exteriorly and in that the internal rib is smaller and usually extends to the ventral margin in nearly a vertical line rather than sloping anteriorly.

This new species differs from juvenile forms of *Siliqua alta* Broderip and Sowerby[5] in the more elongated, thinner, more highly colored shell, thinner internal riblet and in that the pallial sinus is narrower and extends forward from the posterior adductor impression before descending.

This new species is named for Lewis Warrington Sloat[6] one of the founders and first secretary of the California Academy of Natural Sciences.

The anatomy of three individuals of the new species was studied by the late Dr. Harold Heath. Two have a shell length of 34 mm. and the third specimen, of approximately the same size, had been removed from the shell. The first two were taken off Laguna Point, Mendocino County, California, in 46 to 49 meters (25.5-27 fathoms); the other came from a depth of 155 to 157 meters (85-86 fathoms), off Mad River, Humboldt County, California. Specimens of *Siliqua patula,* with whose anatomy that of *S. sloati* was compared, were collected at Pismo Beach, California, and range in length from 32 to 116 mm. Unfortunately no preserved specimens of the anatomy of *S. lucida* were readily available to enable Dr. Heath to make a comparison with that species.

Dr. Heath gave the following discussion of his study of the anatomy of the two species.

Externally *S. patula* and *S. sloati* resemble each other closely, but there are significant differences. One difference is the degree of pigmentation. In *S. patula* all traces of pigment are lacking or are confined to the bases of the few papillae surrounding the siphonal openings. In the new species, taken from a depth of ap-

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(4) *Solen patulus* Dixon, Voyage Round the World, p. 355, fig. 2 [two figs.], 1789. "At the mouth of Cook's River," northwest coast of America [Alaska]. — I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci. Vol. 1, p. 190, pl. 48, fig. 1; pl. 52, fig. 1, 1924 (as *Siliqua patula*).

(5) *Solen altus* Broderip and Sowerby, Zool. Jour., Vol. 4, No. 15, p. 362, 1829. "Hab. in Oceano Arctico." — I. S. Oldroyd, Stanford Univ. Publ. Univ. Ser. Geol. Sci., Vol. 1, p. 190, pl. 47, figs. 1, 2, 1924 (as *Siliqua patula alta*). "Swikshak Beach, Alaska."

(6) See Hertlein, L. G., "Lewis W. Sloat Pioneer Conchologist in California," Amer. Malacol. Union 25th Anniversary Issue. Ann. Repts. 1956 (Bull. No. 23), pp. 7-8, December 31, 1956.

proximately 155 meters (85 fathoms), pigment is lacking entirely. In the two from shallower water the siphons and sensory papillae fringing the mantle border are provided with a brownish pigment, and the foot also is blotched with the same material.

It is worthy of note that in the deeper water individual the mantle papillae, along the front margins of the shell, are greatly reduced, and the siphon surface is as smooth as in *S. patula*. In the other two specimens the papillae are as prominent as in *S. patula*, and the siphons are provided with what evidently are sensory outgrowths (Pl. 6, Fig. 5). Obviously, the presence or absence of these structures is correlated with the amount of light, which conceivably may act as a developmental stimulus.

The musculature of these species is altogether too resistant to permit of a detailed dissection. However, it may be said that the pedal protractors originate as paired bundles in the neighborhood of the anterior shell adductor, and, although their component fibers appear to merge, they nevertheless are distinct throughout. Those of the group adjacent to the adductor form in part the lateral wall of the visceral cavity, while others radiate more ventrally and enter into the formation of the median and more posterior divisions of the foot. The other member of this pair extends into the more anterior portion of the foot, and in both species their radiating fibers evidently cooperate with intrinsic circular muscles in decreasing the caliber of the foot, thus causing its extension.

In this process of extending the foot the transverse muscle bundles bridging the visceral cavity also may play a part. Their contraction obviously must constrict the pedal sinuses, and if the

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Explanation of Figures on Plate 6

Fig. 1. Lateral view of stomach and digestive gland of *Siliqua patula*. Shell length, 116 mm.

Fig. 2. Right half of body of *Siliqua patula*, showing internal features of stomach, arrangement of pedal protractors and of the muscles spanning the visceral cavity. Shell length, 32 mm.

Fig. 3. Lateral view of the digestive system of *Siliqua patula*. Shell length, 116 mm.

Fig. 4. Lateral view of the digestive system of *Siliqua sloati*.

Fig. 5. Siphon of *Siliqua sloati*, from 46 meters (25 fathoms).

Fig. 6. Right side of stomach of *Siliqua sloati*.

Fig. 7. Right half of body of *Siliqua sloati*.

Fig. 8. Right lateral view of stomach of *Siliqua patula*. Shell length, 32 mm.

Fig. 9. Dorsal view of main organs of *Siliqua patula*. Shell length 55 mm.

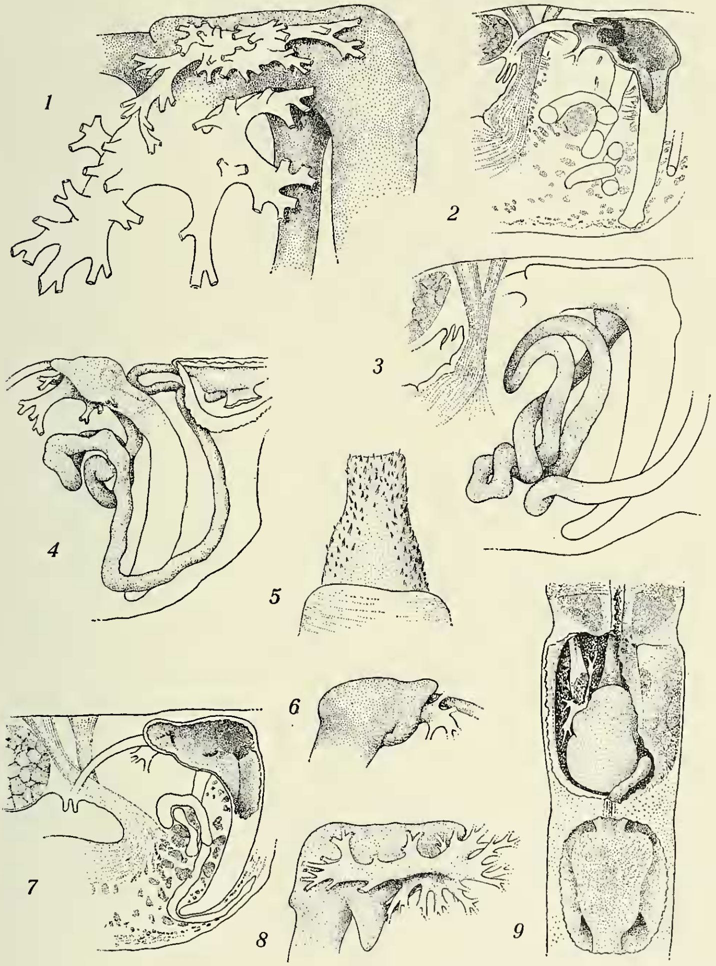

PLATE 6

The explanations of figures and the line drawings used for illustrations on this plate were prepared by the late Dr. Harold Heath.

contained blood is forced anteriorly it produces a forward extension of the foot. It is important to add that here, as in several other genera, the arrangement of these muscles constitutes an important item in the list of specific differences.

Fundamentally the digestive system in both species is constructed upon the same plan. There are, however, several obvious differences. The esophagus in each is dorso-ventrally compressed to some extent, is of essentially the same diameter throughout, and in most instances the inner epithelial lining is marked by delicate longitudinal grooves.

Among what appear to be the more primitive pelecypod families, the stomach comprises two divisions, a dorsal and ventral section. Ducts from the digestive gland open into the dorsal division, and the crystalline stile secretion is developed by the lining cells of the lower portion. In *S. patula* the upper region is typical, whereas the lower section no longer is continuous with the intestine, but has become fashioned into a capacious diverticulum. The intestine therefore directly unites with the upper division.

The configuration of the stomach proper is similar in both species. The chief differences being those of proportion. One striking variation appears in relation to an out-pouching from the right side of the gastric wall. In *S. patula* (Pl. 6, Fig. 8) it is a conspicuous plain-walled structure; in *S. sloati* it is situated more anteriorly, is relatively of small size and its lining is fashioned into several distinct folds. Developmentally the bile ducts originally were doubtless paired, and this condition persists in *S. sloati* (Pl. 6, Figs. 4, 6). In *S. patula* (Pl. 6, Figs. 1, 8) the main duct of the right hand gland is single; the left, on the other hand, has a single duct with ventral opening, and more dorsally there may be one or several connections.

The diverticulum responsible for the crystalline stile secretion is a plain-walled structure in both species. In primitive pelecypods, where the lower division of the stomach is attached directly to the intestine, a longitudinal groove is reported to be the channel whereby nutritive material is passed along to the intestine. In the genus *Siliqua* the same groove persists (Pl. 6, Figs. 2, 7), but obviously, if originally it constituted a transportation feature, it no longer carries on the same function.

The intestine in the two species differs with respect to relative length and in the arrangement and disposition of the coils. With the exception of slight variations the general plan in *S. sloati* is that represented by Plate 6, Fig. 4. In all specimens of *S. patula,* with a shell length ranging from 32 to 116 mm., the condition of affairs is shown on Plate 6, Fig. 3. Evidently, therefore, these differences are not due to size or age differences, and furthermore the position of several of the transverse muscle bands precludes the shifting to any considerable degree of the intestinal tract. It may be added that the intestine penetrates the heart.

The gonads of specimens of *S. patula* taken in early June contain fully developed eggs; those collected in late summer evidently had passed the breeding season. In this last named collection the reproductive gland presents essentially the same appearance as in the case of individuals of *S. sloati* dredged in the month of August. It therefore is difficult to determine whether this last named species is represented by adult individuals. No sections were made of the gonad or kidney of either species, and their relations to each other are unknown.

The pericordial cavity is single, no dorsal or ventral septum being present. The general position of the organ is represented on Plate 6, Fig. 9.

POPULATIONS OF THE BUTTERFISH, *PORONOTUS TRIACANTHUS* (PECK), WITH SYSTEMATIC COMMENTS[1]

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ABSTRACT

Examination of large series of butterfish from throughout their range revealed three major populations: a deep-bodied form in the Gulf of Mexico; an intermediate form in Western Atlantic waters of 12 fathoms or less south of Cape Hatteras; and a generally shallow-bodied form in Western Atlantic waters north of Hatteras and south of Hatteras beyond 13 fathoms. *Peprilus burti* Fowler is placed in the synonymy of *Poronotus triacanthus* (Peck).

INTRODUCTION

The butterfish, *Poronotus triacanthus* (Peck), a fish of the family Stromateidae, constitutes an important human food and sport resource in parts of its range, particularly in New England

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waters (Bigelow and Schroeder, 1953: 367) and the mid-Atlantic states (Hildebrand and Schroeder, 1928: 215). This species also finds many uses as a commercial scrap fish in various processed forms and as crab bait and fertilizer — in addition to being, through its large numbers, a valuable forage species.

During the course of routine identifications of fishes from the Western Atlantic and Gulf of Mexico at the University of Florida and at the U. S. Bureau of Commercial Fisheries Biological Laboratory at Brunswick, Georgia, it was thought that perhaps more than one species of *Poronotus* was being encountered. Preliminary investigations based on few specimens revealed the presence of a shallow-bodied Atlantic form and a deeper-bodied Gulf form. Fowler (1944:1) described the latter as a species of *Peprilus,* another stromateid genus, though it is clearly a form of *Poronotus* as determined by examination of the types which show a row of pores beneath the dorsal fin and much lower dorsal and anal fins. Fowler (p. 4) figured the pores and these fins properly and called (p. 2) particular attention to the pores. *Peprilus* lacks the pores and has high, falcate vertical fins. The two genera are easily distinguished. The types of *Peprilus burti* are especially deep-bodied, which may account for Fowler's generic placement. Specimens of *Peprilus* are usually deeper-bodied than most individuals of *Poronotus.* Fowler (1933: 61) had earlier identified these same specimens (as shown by labels in the jars with the types and by his own synonymy in describing *Peprilus burti*) as *Poronotus triacanthus. Peprilus burti* Fowler is therefore placed in the synonymy of *Poronotus triacanthus,* a wide-ranging species.

In view of the two seemingly geminate species or populations, large series of butterfish were assembled from throughout the range to analyze their variation. A number of meristic, proportional, and pigment characters were examined, but all except body depth were discarded because of extensive overlapping. Although quite variable and subject to overlap in local and regional stocks, body depth, on a mean basis using large numbers of specimens, does suggest the existence of three separate populations which may prove useful in future fishery studies on butterfish.

Methods

Standard length (recorded to the nearest tenth mm.) was measured with dial calipers, placing one point of the jaws at the base of the mid-caudal rays (distal end of the hypural plate) and the other at the tip of the upper jaw with the specimen's mouth closed. Body depth was measured with one point of the dial calipers hooked over the exposed preanal pterygiophore and the other

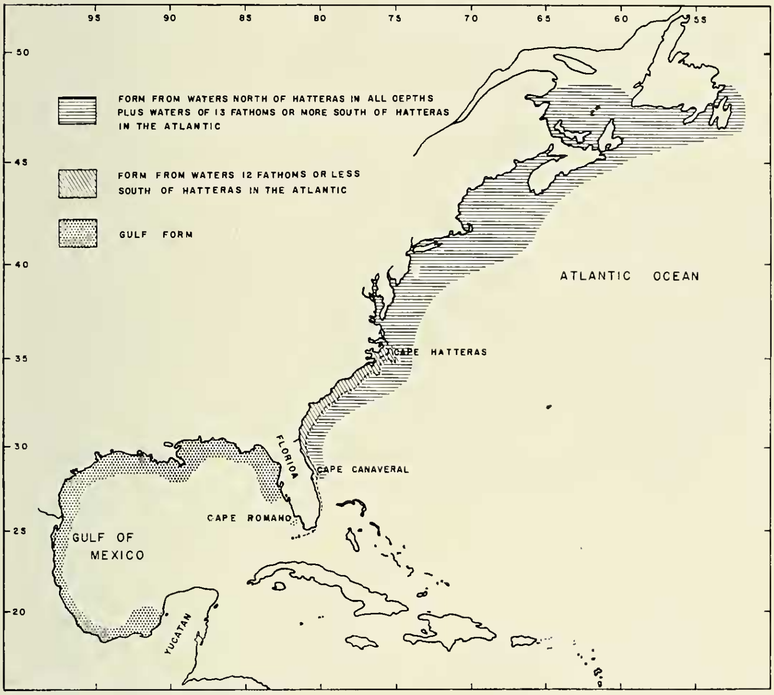

PLATE 7

Geographical distribution of *Poronotus triacanthus* (Peck). Three apparent populations, unnamed, are also shown. Dashed line off the south Atlantic coast denotes approximately the 10-fathom depth curve.

in a vertical from this point at the base of the dorsal fin. Standard length-body depth ratios were calculated to the nearest hundredth and rounded to the nearest tenth.

Water-depth data for a station often included a range through which the collecting gear (usually bottom trawls) was used (for example, "25 to 27 fathoms"). A mean depth value, rounded to the nearest fathom, was determined (in this example, 26 fathoms). Station localities are midpoints between the start and finish of trawling drags.

MATERIAL EXAMINED

Most of the specimens examined were obtained through the exploratory fishing operations in the Gulf of Mexico and in the Atlantic south of Cape Hatteras, North Carolina, by the U. S. Fish and Wildlife Service vessels OREGON, SILVER BAY, COMBAT, GEORGE M. BOWERS, and PELICAN. Additional material was obtained from shrimp trawlers in the Brunswick area and from crab bait brought from Portsmouth, Virginia, to the Lewis Crab Company at Brunswick. Gifts of material came from the University of Delaware through Dr. Donald P. deSylva and from the U. S. Bureau of Commercial Fisheries Biological Laboratory at Woods Hole, Massachusetts, through Robert L. Edwards. Specimens were borrowed from or examined at the following institutions: Academy of Natural Sciences of Philadelphia (types of *Peprilus burti*), through Dr. James E. Bohlke; University of Florida Collections, through Dr. John D. Kilby; Tulane University, through Dr. Royal D. Suttkus; University of Miami Marine Laboratory, through Dr. C. Richard Robins; U. S. National Museum, through Dr. Leonard P. Schultz; California Academy of Sciences, through Dr. W. I. Follett, and University of Georgia, through Dr. Donald C. Scott.

GEOGRAPHICAL RANGE

Based on literature, museum specimens, and station records from exploratory operations conducted by the U. S. Bureau of Commercial Fisheries, *Poronotus triacanthus* ranges (Plate 7) in the northwestern Atlantic from the outer coast of Nova Scotia and Cape Breton, and northward as a stray to the Gulf of St. Lawrence and to the south and east coasts of Newfoundland (Bigelow and Schroeder, 1953: 365), southward to 28°03′ N., 79°52′ W., in 150-175 fathoms (PELICAN station 25) and 28°03′ N., 80°29′ W., in 8 fathoms (SILVER BAY station 239) both in the vicinity (to the southward) of Cape Canaveral, Florida. There is an apparent discontinuity around the tip of the Florida peninsula to about Cape Romano (at 25°54′ N., 81°45′ W., SILVER BAY station 524) in the Gulf of Mexico. The species ranges widely around the perimeter of the Gulf to a recorded extreme of 21°45′ N., 91°30′ W., SILVER BAY station 341, off the western side of the Yucatan peninsula in Mexico.

Fishes ranging this far into Yucatan waters *may* also occur to the northeastern tip of the peninsula (Caldwell, 1955: 233). However, the butterfish may be somewhat restricted by bottom type. Bigelow and Schroeder (1953: 363) noted that in the northern part of its range the species shows an apparent preference for sandy bottoms, as opposed to rock or mud. A different situation

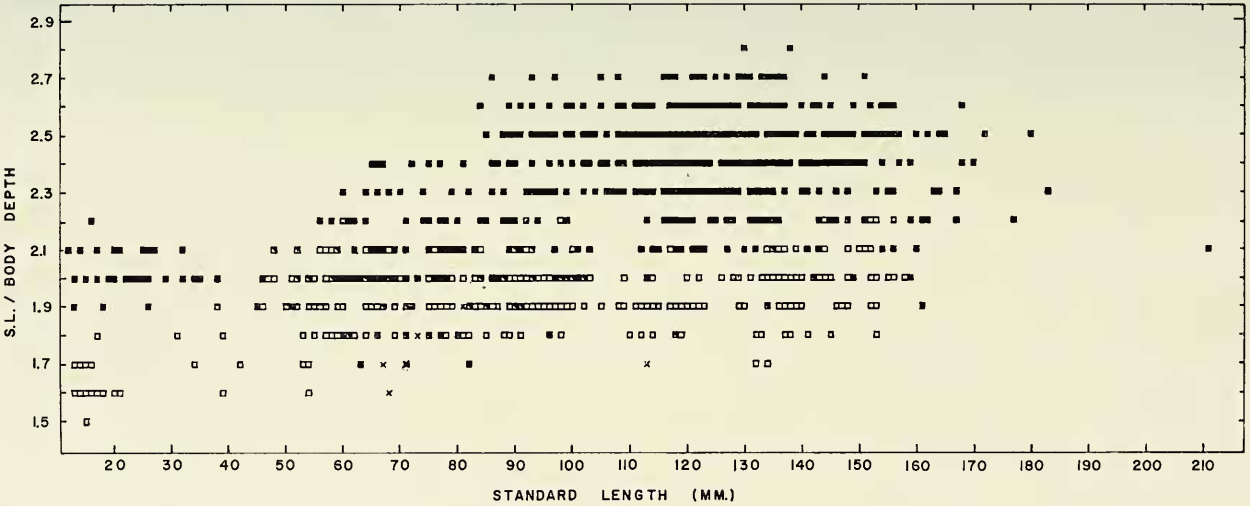

PLATE 8

Relationship between standard length and relative body depth for *Poronotus triacanthus* (Peck). Solid squares denote Atlantic specimens, open squares Gulf of Mexico specimens. Each symbol represents one or more individuals. Crosses denote types of *Peprilus burti* Fowler, a synonym.

seems to exist for the Gulf and for an inshore Atlantic form south of Hatteras. A soft bottom seems to be preferred, as determined from station data and hydrographic charts. This restriction may play a part in the distribution in the Gulf and on the Atlantic side of the lower part of the Florida peninsula. The bottom off the northern part of the Yucatan peninsula is generally hard (Lynch, 1954: 79).

Recent studies by Moore and Gorsline[3] show a hard bottom off the Atlantic Florida coast from somewhat south of Cape Canaveral southward. The offshore bottom on the Continental Shelf along the entire South Atlantic coast also is hard, extending inshore to about 10 fathoms, thus associating ecologically the deeper population noted below with the northern stock.

The Cape Romano specimen may be a straggler, or a misidentification (the record is based on an unsupported field report). Despite considerable exploratory work by the Service in the intervening area, there are apparently no other Florida records south of Big Sarasota Bay, Florida (about 27°30′ N.), California Academy of Sciences (CAS 17237). The nearest northerly record based on Service explorations (again, with much work in the intervening area) is at OREGON station 2158 (28°04′ N., 83°42′ W.) off Tarpon Springs, Florida. Thus, except for one possibly erroneous record, the waters of the entire southern half of the Florida peninsula are apparently devoid of butterfish. This break in range, possibly related to bottom type, may act as an effective barrier to gene flow between Gulf and Atlantic populations.

There are no records of *Poronotus* from the Caribbean, the Bahamas, or from Bermuda.

Population Analysis

The ratios of standard length to body depth for all specimens examined, regardless of size and depth of capture, were compared simply by plotting the ratios against standard length for the Gulf forms versus the Atlantic (Plate 8). Although many specimens from the two areas overlap, it is evident that many from the Atlantic are more slender than any of those from the Gulf. Examination of Plate 8 reveals that up to about 80 mm. standard length there is a tendency for relative body depth to decrease with increase in length. As this ontogenetic change tended to complicate the problem of geographic variation, only fish 80 mm. in standard

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[3] Moore, Joseph E., and Donn S. Gorsline. *in press.* Physical and chemical data for bottom sediments South Atlantic coast of the United States M/V Theodore N. Gill cruises 1-9. Spec. Sci. Report — Fish., U. S. Fish and Wildlife Service.

length or larger were considered further. The geographic relationship discussed for adults holds for smaller specimens, however. The early development of *P. triacanthus* has been summarized by Pearson (1950: 87).

There is also a slight tendency for specimens from deeper water to be shallower-bodied (Plate 9). However, since large series from both deep and shallow water produced individuals encompassing nearly the full range of relative body depths, as well as actual lengths, this factor was disregarded in considering populations.

Butterfish may occur in surface or midwater schools or at or near the bottom. Fathometer traces of butterfish schools were recently illustrated in a report of cruise number 65 of the OREGON. These indicate that a school (in March, at least) may extend through a considerable range of depth, from quite near the bottom up into midwater. Since it was not determined whether most specimens used in this study were taken on the bottom or by the trawl as it was going down or coming up (also noted by Bigelow and Schroeder, 1953: 364), water depths at the stations were used in making comparisons, although the fish themselves may have come from a somewhat shallower depth. There were so many catches in depths of 100 to 200 fathoms that the occurrence of the species at these depths is considered real.

Despite the above clouding phenomena, examination of series of adults provided evidence for the following populations when the factor of depth occurrence in the Atlantic specimens is also considered. (1) All of the Gulf forms. (2) The fish occurring south of Cape Hatteras to a depth of approximately 12 fathoms. (3) The fish south of Cape Hatteras occurring in depths of about 13 fathoms or more, plus those north of Cape Hatteras. These three populations are illustrated in Plate 7.

The exact depth division between the two populations occurring south of Cape Hatteras is difficult to determine because of inadequate samples in the 10- to 20-fathom range, but it apparently lies at about 12 fathoms, and there is undoubtedly some overlap between the two. Bottom type may, in fact, account for this distribution (see Geographical Range, above).

Bigelow and Schroeder (1953: 364 and 366) postulated a winter offshore movement in the north and at least south into Carolina waters. This is at variance with the results of this study, and except for the lack of records of specimens less than 45 mm. standard length from the deeper-water population south of Hatteras, possibly due to mechanical failures in collecting, two other factors seem to bear out the apparent validity of two groups in these more southerly waters: (1) ripe individuals have been taken

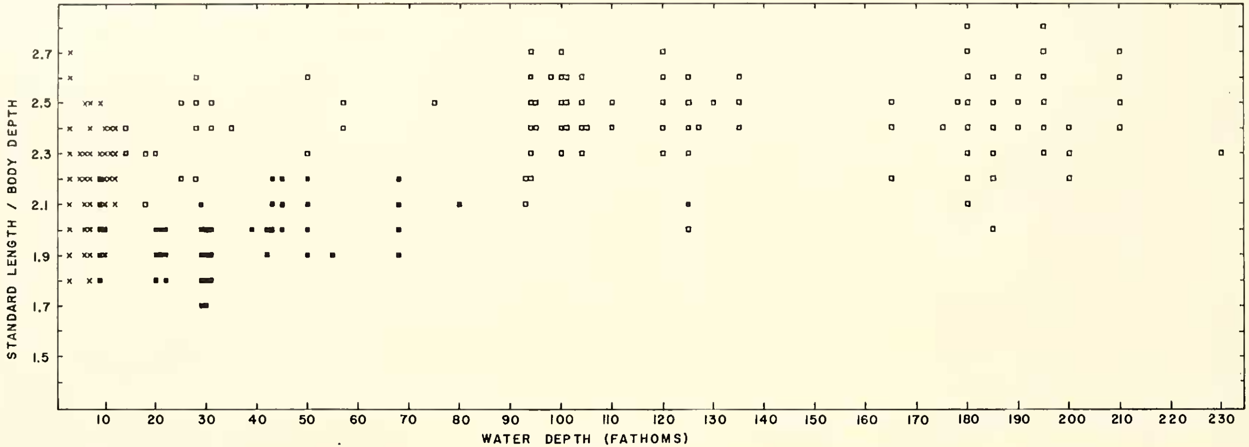

PLATE 9

Relationship between water depth and relative body depth of *Poronotus triacanthus* (Peck), greater than 80 mm. standard length, from the Gulf of Mexico (solid squares), waters 13 fathoms or greater south of Cape Hatteras plus all depths from north of Hatteras (open squares), and from waters 12 fathoms or less south of Hatteras (crosses). Each symbol represents one or more individuals. Note the specimens from the Gulf are not known out to as deep water as those of the Atlantic — despite extensive trawling in the Gulf to depths much greater than 125 fahoms.

from both populations, and there is thus apparently no significant spawning migration; (2) collections during each season of the year and in almost every month have produced specimens larger than 100 mm. standard length from most depths, including particularly the two populations.

The three populations were first visualized from preliminary studies on which Plate 8 is based, and proved clearer when the specimens from the Gulf and the Atlantic were compared in relation to water depth (Plate 9, considering the two Atlantic populations so depicted as one). They proved more valid when they were taken as groups and considered as such with reference to each other. The relationship between the populations of the Gulf and offshore south of Hatteras plus those north of Hatteras is graphically depicted in Plate 9. The actual numbers of specimens involved in each relationship are shown in Table 1. Based on Ginsburg's (1938: 261) arithmetical definition of the taxonomic concept, these two populations show a divergence of 70 percent and would therefore be considered subspecies. In such a case, the name *Poronotus tricanthus burti* (Fowler) would be available for the Gulf form (type locality, Breton Island, Louisiana) and *P. t. triacanthus* (Peck) for the Atlantic form, since Peck's type came from the Piscataqua river in New Hampshire (Peck, 1800: 48). A synonym of *P. triacanthus, Stromateus cryptosus* Mitchell (1815: 365), also came from northern waters — New York Bay.

However, when the Atlantic inshore population south of Hatteras is compared with the two above, Plate 9 and Table 1, it completely overlaps both, with the exception of two very slender individuals, and on a mean basis, relative body depth for this population also lies intermediate between those of the others. Series of specimens from about 3 fathoms in the Brunswick shrimp trawling area span this range, and the great variation is considered real rather than being an artifact showing the influence of ecological overlap in the 12-fathom range mentioned earlier in this paper. While on a mean basis this inshore Atlantic population can be distinguished from the other two, the overlap which thus links all three seems to make it useless to try to distinguish the three on a nomenclatorial basis.

Therefore, while the knowledge of the existence of three apparent major populations of butterfish should prove useful in management of the species, for the present it seems that no useful gain would be had in naming them. *Peprilus burti* Fowler, actually *Poronotus burti* (Fowler), is placed in the synonomy of *Poronotus triacanthus* (Peck) until such time that some future studies prove taxonomic distinction valuable. The three populations do seem to be in a process of divergence through geographical and ecological isolation (in the Atlantic, especially bottom, depth, and/or possibly temperature related to geography and depth), but at present they seem merely to represent a cline, with the extremes arithmetically distinguishable on a mean basis as subspecies. The extreme variation in relative body depth within this species is illustrated in Plate 10.

Acknowledgments

Aside from the persons noted above as having furnished material, I am especially indebted to Harvey R. Bullis of the U. S. Fish and Wildlife Service at Pascagoula, Mississippi, for specimens from the exploratory vessels under his charge and for the opportunity to examine the station records from those vessels. Frederick H. Berry, now of the Bureau of Commercial Fisheries Biological Laboratory at La Jolla, California, examined the holotype and two of the paratypes of *P. burti* and also made many useful suggestions at the onset of the study. Much assistance and many helpful comments came from members of the staff of the Brunswick Laboratory. Of these, I am particularly indebted to William W. Anderson, Jack W. Gehringer, and my wife Melba C. Caldwell for their critical examination of the manuscript.

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PLATE 10

Specimens of *Poronotus triacanthus* (Peck) showing variation in relative body depth (given below in parentheses). Top to bottom: 130.4 mm. S.L., (2.8), from SILVER BAY station 470, 29°48′ N., 80°12′ W., 195 fath. off St. Augustine, Florida; 129.7 mm. S.L., (2.4), from about four fathoms near Portsmouth, Virginia; 131.8 mm. S.L., (2.1), from about four fathoms near Portsmouth, Virginia; 131.9 mm. S.L., (1.7), from SILVER BAY station 844, 20°01′ N., 91°47′ W., 30 fathoms off Campeche, Yucatan. Disregard the differences in color and color patterns.

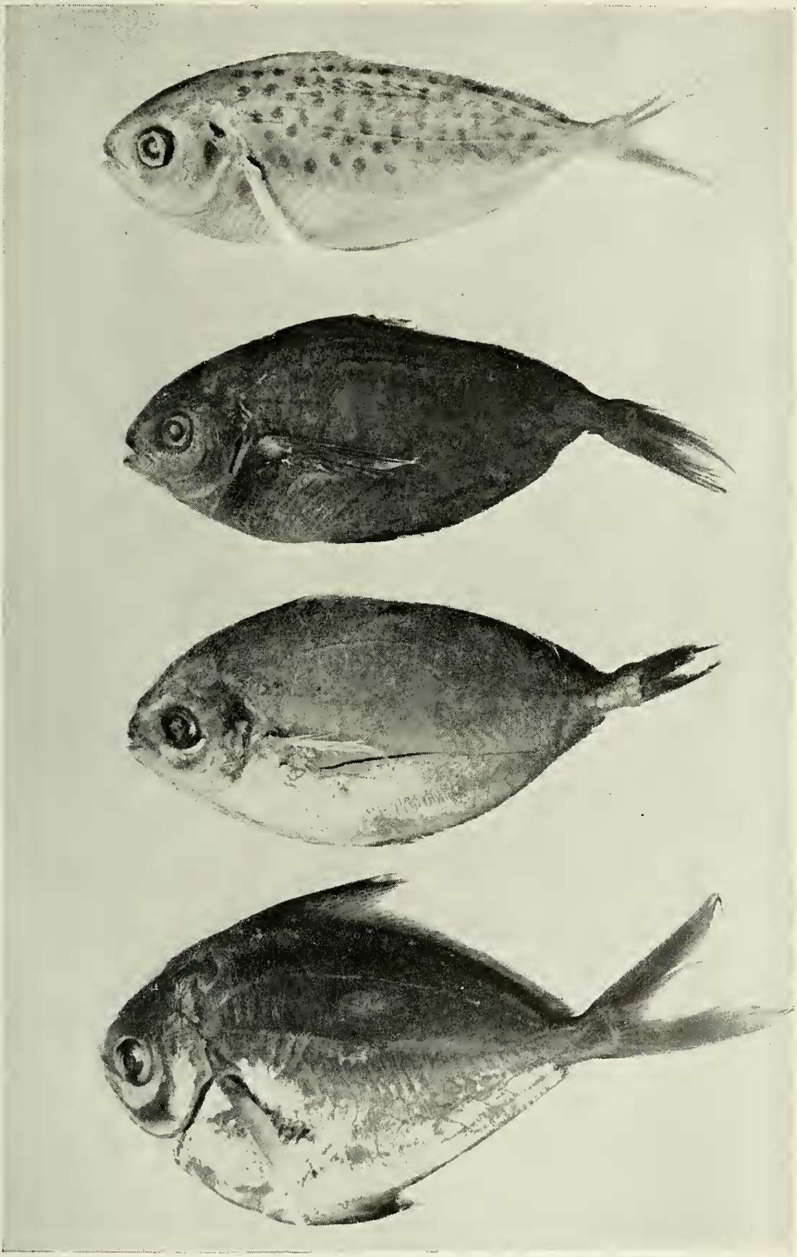

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Table 1. — Frequency distribution of relative body depths in *Poronotus triacanthus* (Peck) 80 mm. standard length or more.

Population	Mean	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
1. Gulf of Mexico in all depths.	2.0 (1.95)	3	25	75	78	19	7						
2. Atlantic south of Cape Hatteras from depths of 12 fathoms or less.	2.2 (2.19)	1	2	9	17	28	28	38	12	3	2	1	
3. 3a and 3b combined.	2.4 (2.44)				5	12	29	72	120	147	85	26	2
3a. Atlantic south of Cape Hatteras from depths of 13 fathoms or more.	2.5 (2.46)				3	8	12	46	77	96	62	20	2
3b. North of Cape Hatteras in all depths.	2.4 (2.42)				2	4	17	26	43	51	23	6	

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A NEW TROGLODERUS FROM THE AEOLIAN SALINE DUNES OF SOUTHERN CALIFORNIA

(Notes on North American Coleoptera, No. 15)

By Charles S. Papp

The Tenebrionid genus *Trogloderus,* which is one of the most interesting paleo-entomological groups of rare beetles, has been treated by Ira La Rivers (1942). The generic relationship in comparison to some of the closely related genera also were discussed by him (1948). In another paper La Rivers (1946) modified the specific value of all species known at that time, and except for *costatus* LeC., he sank all into subspecific rank. His excellent discussion and evaluation of concrete facts and theoretical ideas concerning the evolution of this remarkable Tenebrionid is a must for those who are engaged in the study of our deserts. Here is an example of an insect, entirely bound to the ground, with some special and as yet unknown processes of complete adaptation to the great environmental changes that have occurred. This genus could be used as a stepping stone to a greater understanding of the evolutionary processes through the ages.

The geological past of this area often has been discussed by several authors (Van Dyke 1932, Spieth 1950, Jaeger 1955, 1957). The old fauna probably appeared during the Oligocene or Early Miocene, when possibly a broader connection between North and South America existed, as a route for the migration of species of the southern fauna. Then, when the climate became cooler and the once flat land began to rise, a great change took place in this territory. The species of warmer origin were exposed to great climatic stress. Those that survived began to change in habits and also in form. Many of them, however, such as the phytophagous forms, could not survive so well, and they gradually disappeared. These environmental changes have been frequently discussed, but first hand information, ("on the spot" observations) of this fascinating problem is needed to understand all those dramatic events which give our deserts their thousand faces. The writings of Jaeger (1957, etc.) and Spieth (1950) are highly recommended to those concerned with North American deserts.

Sporadically there are a few reports (other than those of La Rivers, cited earlier) on *Trogloderus* from the southwestern United States. Most recently Papp and Pierce (1960) reported the collection of fairly large numbers of this rare beetle in stored chicken feed in the high desert area of Mojave. These were *T. costatus tuberculatus* Blaisd., collected in September 1958. I did not have the good fortune to observe other specimens before or since, until I received a large number of beetles (99% Tenebrionids) from Dr. W. W. Mayhew, Assistant Professor of Zoology, University of California, Riverside, Calif. These beetles had fallen into his traps that were set for desert reptiles in the aeolian saline sand dunes near Dale Dry Lake, San Bernardino County, in the Lower Mojave Desert. This interesting habitat is very seldom visited by collectors. It is a highly arid portion of the Mojave Desert approximately 22 miles east of the desert town of Twentynine Palms. In this material the writer found 6 specimens of *Trogloderus,* collected on October 16th, 1960. Another two specimens were picked up with other trapped Tenebrionids by Mayhew's coworkers (Walter Moberly and Betty Aaron) on December 23rd, 1960 at the same location. No *Trogloderus* were found in all the trapped material Dr. Mayhew obtained from other areas of the desert (Palm Springs and Algodones Dunes). After careful study of these specimens, I found this group to be new to science and will describe it below. There is now one species (*T. costatus LeC.*) and four subspecies (including this new one) known to science, and all are members of the fauna of North America (Papp, 1961-a).

Trogloderus costatus **mayhewi** Papp, new subspecies (Plate 11). — It is easily recognized by its black color, strongly developed longitudinal ridges on the elytra and by its broad pronotum. — The HEAD is slightly wider than long, very coarsely, irregularly granulate. The transverse impression of the vertex deep at base; on the deepest anterior edge very finely at the shallower posterior edge very coarsely granulate. The central elevation with rough granulation is slightly divided by an irregular short groove. The pre-ocellar edge widely rounded, labial margin slightly curved, heavily granulated. Eyes small, deeply set and partially covered by the end of the transverse groove of vertex. — PRONOTUM as wide (♀) or wider (♂) than the elytra on its widest point. Lateral margin evenly rounded, slightly wider behind middle, more or less evenly annulated; the annules somewhat sharp and each annule with a short but strong black seta (which can not be indicated on the enclosed illustration). Anterior angles sharp, pointed, with a deeply set anterior, and with a more or less even posterior margin, with a short but sharp posterior angles. Sides broad, almost flat, very coarsely granulated; just before the elevated center portion begins with large irregularly shaped impressions with sharp and shiny edges. The elevated portion similarly but somewhat finely granulated, with a shallow transverse impression, which occasionally in deeper in its posterior end. — ELYTRA as wide (♂) or slightly wider (♀) than the pronotum, with four prominent

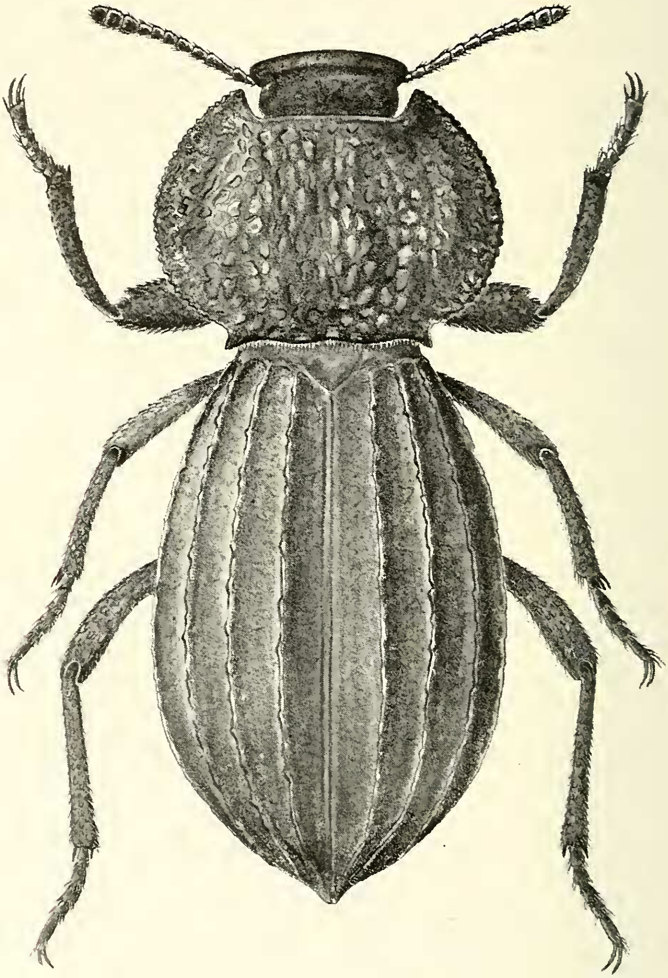

PLATE 11

Trogloderus costatus mayhewi Papp, new subspecies.
(Drawing by the author)

longitudinal ridges, from which the two external costa shallow, the others gradually higher toward the middle of the elytra, the fourth is the highest. All the ridges are continuous, shiny, slightly uneven in their longitudinal line. The caudal ends shallow and are individual endings. The intercostal spaces are sharply concave, more or less opaque, with a very slim remains of shallow punctures, which are hardly visible on some specimens. There are no setae present.— LEGS, especially the anterior pair, roughly granulate, the others smoothly punctulated, all on their ventral side with golden, sharp setae. The profemora with a blunt tooth, the protibiae with a broad tooth dorsally and with two narrower ones ventrally. — ABDOMEN flat, somewhat concave, sides smoother, other parts finely granulated and sporadically covered with short golden yellow setae. — Length: Males 8.0-11.7 mm., Females 9.5-13.5 mm.

LOCALITY: Dale Dry Lake, southern San Bernardino County (the lower Mojave Desert area), California. Six specimens were collected on October 16, 1960, two specimens on December 23, 1960. The area was generally discussed in another paper (Papp, 1961-b) in connection with the description of a new *Saprinus*. — Type (male) deposited in the type collection of the Department of Entomology, Los Angeles County Museum, Los Angeles, Calif.; female specimen deposited at the same place. — Paratypes: One specimen in the collection of the Division of Life Sciences, University of California, Riverside, Calif.; one specimen in the British Museum (Natural History), London, England; one specimen in the Rijksmuseum van Natuurlijke Historie, Leiden, Nederland; one specimen in the collection of the Swedish Academy of Sciences, Rijksmuseum, Stockholm, Sweden.

Specimens of *Trogloderus costatus tuberculatus* Blaisd. also have been sent to the above mentioned institutions, plus the Museum Georg Frey, Tutzing bei München, Germany.

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EXTENSIONS OF RANGE AND A NEW HOST PLANT OF PHILOTES SPECIOSA

(Lepidoptera: Lycaenidae)

By Fred Thorne, El Cajon, Calif.

The capture of a specimen of *Philotes speciosa* (Hy. Edw.) by Mr. William Hedges of Spring Valley on March 8, 1959 at Sweeney Pass, fifteen miles north of Jacumba, San Diego County, is a noteworthy extension of range. This record came to my attention too late in 1959 to permit exploring the area for additional specimens.

On March 11, 1960 Mr. O. E. Sette of Los Altos, California, and the writer spent some time in scouting Sweeney Pass, but were unsuccessful in finding the insect despite ideal weather conditions. However, on March 15, 1960, on our return from a collecting trip to Arizona, we stopped at the bottom of In Ko Pah Gorge east of Jacumba, where Mr. Sette collected two freshly emerged specimens near the thousand foot elevation marker on U. S. Highway 80. This location is approximately thirty miles west of El Centro in western Imperial County. An intensive search of the canyon disclosed no additional specimens.

On March 16, a trip to this spot was made in company with Mr. Hedges, and in two hours, thirteen specimens including eight females were taken, leaving no doubt that this species is established well south of the recorded range in the Mojave Desert.

The larval foodplant in the Mojave Desert was found to be *Oxytheca perfoliata* T. and G. by Comstock and Dammers, but this plant is absent at Sweeney Pass and at In Ko Pah Gorge. The insect semed to be associated with a small species of annual Eriogonum in the gorge and here on April 2, 1960 a female was observed ovipositing on the involucres of the flowers of this plant. Mr. Oscar F. Clark of Riverside, Calif. has kindly identified this plant as *Eriogonum reniforme* Torr. and Frem. A careful search disclosed several more eggs, and at Sweeney Pass ova were found abundantly on this same plant as well as at Mountain Palm Springs a few miles north of there where *speciosa* was flying in large numbers.

On April 9, 1960 the insect was found in abundance in the Kramer Hills near Boron in San Bernardino County where females were observed ovipositing on the terminal involucres of *Oxytheca perfoliata*. However, two days later at a location south of Rabbit Dry Lake in Lucerne Valley, Mr. John Montgomery of Redwood City, Calif. and the author each took a single specimen of *P. speciosa* where no *Oxytheca* could be found. A search of *E. reniforme* plants in the area disclosed several eggs, hence this plant appears to be a suitable host in the Mojave desert area also.

Comstock and Dammers have recorded the curious larval habit of feeding only on the small fleshy points which arise from the stem around the leaf junctures on *O. perfoliata*. Since these points are lacking on *E. reniforme* the larvae probably feed on the floral parts but there was no opportunity to verify this.

This choice little blue was described by Henry Edwards in 1876 from a single specimen taken by R. H. Stretch at Havilah, Kern County, California. Comstock and Damners have recorded captures in Upper Mint Canyon, Los Angeles County; from the lower Mojave Desert near Victorville; and the "Box S" Ranch in San Bernardino County, as well as the Randsburg area of eastern Kern County.

Dr. R. H. T. Mattoni of Los Angeles, an authority on the *Philotes*, has kindly verified identification of the specimens reported herein, and has also added a record of a single specimen from Maricopa, Kern County, and captures in the vicinity of Little Rock, Los Angeles County where *Oxytheca trilobata* Gray appears to serve as the foodplant. Mr. Robert Langston of Berkeley has shown me a fresh male specimen captured Apr. 9, 1960 west of Lone Pine in Inyo County on Tuttle Canyon Road in the Alabama Hills.

The discovery of this butterfly in the southwestern edges of the Colorado desert indicates that it should extend into adjacent northern Baja California which offers very similar habitats, and from whence *E. reniforme* has been recorded. It may extend onto the Colorado Desert and perhaps into western Arizona where *Oxytheca perfoliata* grows.

It has undoubtedly escaped the observation of experienced collectors, either because it is difficult to see, flying as it does close to the ground over highly reflective surfaces in the intense desert sunlight, or because it has been mistaken for the ubiquitous *Brephidium exilis* Bdv. Indications are that collectors might expect to discover colonies over a much broader range than is presently known, but that it may require special diligence to locate them.

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BRIEF NOTES ON THE LIFE HISTORIES OF THREE SOUTHWESTERN MOTHS

By John Adams Comstock

GERRA SEVORSA (GROTE)

One of the colorful moths that were taken in quantity near Kohls Ranch, in the Tonto Creek area, Arizona, was *Gerra sevorsa* (Grote). On June 25, 1956 we found six pupae in a piece of dry, pithy wood, each in a separate sealed-in chamber. On the following day we obtained a number of infertile eggs from a female held in captivity. We were unable to find larvae, hence only the egg and pupa are here recorded.

The moth was first described by Grote in Papilio, II, p. 132, 1882, as *Fenaria sevorsa* from a single example taken in "Arizona" by Neumoegen. Druce redescribed it as *Diamuna aedessa,* in Biol. Cent. Amer. 1, Heterocera, p. 334, 1889, and figured it on Plate 30, figs. 21-22.

Notwithstanding the fact that the species is common throughout its range, from Arizona, through Mexico to Guatemala, nothing has apparently been published on its early stages.

Egg: Diameter 0.8 mm., less than half as tall. The color is bright green. Laid (in captivity) singly, or in small clusters.

The egg is a flattened disc, gently rounded toward the micropyle, but with a wide flattened base.

There are approximately 35 ridges, which start at the base and rise toward the micropyle. As this is approached, many of these ridges terminate, and only a dozen or so reach the micropylar margin.

Each ridge is studded with raised points or nodules.

The micropyle is composed of two rings, one within the other. The ridges terminate at the outer ring.

The surface within the rings is not markedly depressed. See Plate 12.

Pupa: Length 15-19. mm. Width 4.5 mm. Color of the wing-cases, thorax and head, blackish-brown; of the abdominal segments brown; the cremaster black.

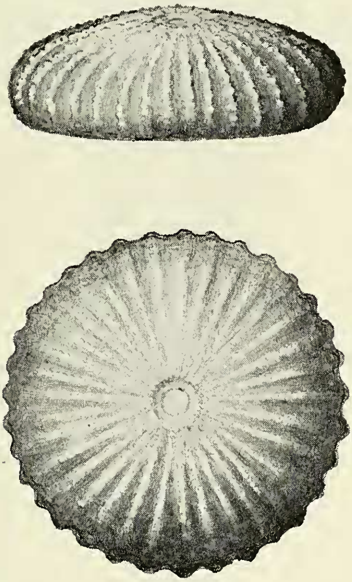

PLATE 12

Egg of *Gerra sevorsa,* lateral and superior surfaces, enlarged × 56.
Reproduced from painting by the author.

The form is fusiform, with the head rounded and the cauda squared.

The entire surface is heavily papillated except for the movable joints of the abdomen. Some of the nodules along the dorsum are extended as short pointed papilliform spines, many of which are recurved.

The antennae extend to the edge of the wing cases, and the maxillae terminate at about three-fifths the distance toward the wing margins. The eyes are not prominent.

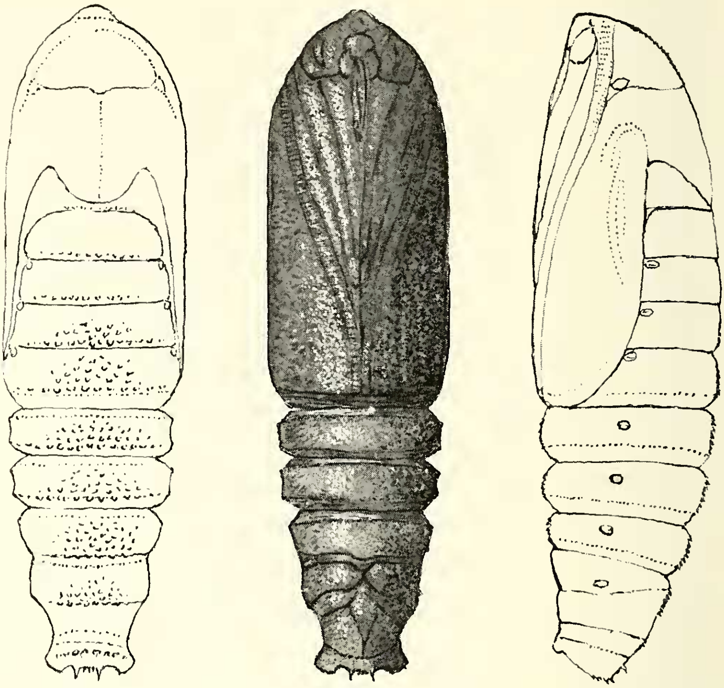

PLATE 13

Pupa of *Gerra sevorsa,* dorsal, vertral and lateral surfaces, enlarged × 6.
Reproduced from painting by the author.

The cremaster, as viewed ventrally, has two blunt knobs, one on each side, pointing caudo-laterally. Between these are a few short sharp spines pointing caudally. There is considerable variation between individuals in the knobs and spines of the cremaster. The spiracles are concolorous with the body.

The pupa is illustrated on Plate 13.

In the Kohl's Ranch area where the specimens were collected, the associated vegetation was dominantly wild grape, Ponderosa pine, sycamore, and wild walnut. We suspect that wild grape is the food plant, but were not able to find larvae on it.

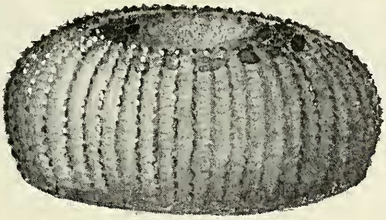

PLATE 14

Egg of *Sarbena extusata,* lateral aspect, enlarged × 84.
Reproduced from painting by the author.

THE EGG AND FIRST LARVAL INSTAR OF SARBENA EXTUSATA DYAR

In August of 1956, I received from my valued correspondent, Noel McFarland, a number of eggs of *Sarbena extusata* Dyar. He had obtained these from a gravid female captured at the 7 C Bar Ranch, seven miles west of Williams, Coconino County, Arizona, sometime between August 9 and 15, 1956.

The eggs hatched August 25 and 26. Since the nearest relatives of *S. extusata* had been reported as feeding on oak and willow, an effort was made to obtain fresh young leaves. We were unable to find suitable willow. Oak was available, as was also *Ceanothus,* both of which were offered to the newly hatched larvae, without avail. Consequently, our notes cover only the egg and first larval instar.

Egg: Hemispherical, the base flattened and the micropylar pit large, deeply depressed and granular. Size, .6 mm. wide by .3 mm. tall. Color, light yellow, with a few red-brown flecks placed irregularly around the micropylar margin.

The surface is covered by about 40 clearly defined ridges, extending continuously from base to micropylar margin. Each ridge is studded along its crest with a line of minute nodules.

In the channels between the ridges there are minute lines or grills running horizontally, in line with the nodules.

The eggs hatched August 25 and 26, 1956. Egress of the larva is made through the large micropylar 'cup', the remainder of the shell being intact. Plate 14 illustrates the egg.

First Larval Instar: Length, 1 mm.

The head and body are uniformly yellow, the tips of the mouth parts only being darker. The head is wider than the body segments.

There are several longitudinal rows of setae running the length of the body. Those on the dorsum are black, the remainder, translucent white.

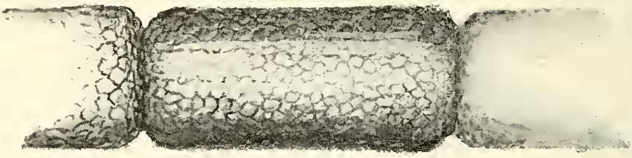

PLATE 15
Egg of *Fernaldella fimetaria* enlarged × approximately 50.
Reproduced from painting by the author.

THE EGG AND FIRST LARVAL INSTAR OF *FERNALDELLA FIMETARIA* (GROTE & ROBINSON)

On June 19, 1958 I received a group of eggs of the beautiful little moth, *Fernaldella fimetaria* from Noel McFarland. They were obtained by him two days earlier, from a gravid female collected at Apple Valley, Mojave Desert, California.

The Egg is regularly cylindrical, slightly flattened, with acutely rounded ends. Length, .75 mm, width, .3 mm. by .15 mm. Color, deep green. The surface has a finely granular appearance, due to a covering of minute hexagonal pits, more or less regularly arranged in rows.

The eggs are usually laid in rope-like rows, attached at their small ends, thus resembling soldered chains.

The eggs hatched June 27, 1958, which gives an incubation period of ten days.

First Instar Larva. Length, 1.8 mm. Head width, approximately .3 mm. which is wider than the first thoracic segment.

The head is a bright yellow, with a tinge of orange. Ocelli, black.

The body is cylindrical. The ground color is light yellow. There is a relatively wide middorsal band of bright yellow, bordered laterally by a wide black band. Latero-inferior thereto the body is a lighter yellow. The ventral surface is slaty-black. Numerous small black dots occur on the body, each topped by a single short colorless hair.

The legs, and two pairs of prolegs are yellow.

The food plant of *F. fimetaria* is unknown, and I was unable to find a plant that was acceptable to the young larvae.

The species is widely distributed, from the Rocky Mountains south to Texas, and west to Arizona, Nevada and California.

The moth is illustrated in Packard's Monograph of the Geometrid Moths, U. S. Geol. Survey (Hayden's), Plate 9, figure 45, 1876. On page *228* of that work, Packard says that the larva is unknown. It seems strange that eighty-three years have had to pass since that statement was published, before a single item appears in print concerning the life history of this colorful and relatively common moth.

A NEW EUPITHECIA FROM ARIZONA (LEPIDOPTERA, GEOMETRIDAE.)

CARL W. KIRKWOOD
Summerland, Calif.

EUPITHECIA CAZIERI n. sp.

Male: antennae finely ciliate; front dark brown, vertex gray; palpi smooth, upturned, extending beyond front, gray flecked with brown. Thorax covered with a mixture of brown and gray scales. Abdomen: first segment gray with an admixture of brown scales, segment II dark brown, balance of segments brown with gray scales intermixed.

Forewing: maculation obscure, ground color gray. Cross lines gray-brown, weakly indicated, strongest on costa. Discal streak black, and is the most prominent feature.

Secondaries: gray with brown scaling in the region of the inner margin. Black discal spot present.

Underside: gray-brown with greatest concentration of brown scales along costa. P.m. and s.t. lines faintly indicated on primaries, stronger on secondaries. Discal spots present on all wings.

Female: same as male, except that the front of head appears to be more gray, and palpi roughly scaled.

Expanse: 15-16 mm. Length of forewing 8-9 mm.

Male genitalia: hair pencils of segment IX well developed. Uncas hooded with two well developed spines. Clasper of moderate width, with broadly rounded apex. Aedeagus moderately broad, vesica armed with two long, pointed, chitinous rods, subparallel to the rods a row of fine spiculations, the usual end piece, and an obscure piece of twisted chitin. Ventral plate of segment VIII subtriangular, shortly bifid at apex with two projecting spines strongly chitinized.

Female genitalia: dorsal plate of segment VIII rectagular, caudal margin with a slight median excavation. Ostium membranous, collar lightly chitinized, ductus bursa starting as a ridge high on the left side of collar and forming a trough, directed downwards and toward the right, terminating in the ductus seminalis, the bursa well covered with long spines.

Holotype male: Southwestern Research Station, Chiricahua Mountains, Cochise Co., Arizona. September 3, 1959.

Allotype female: same data as the holotype.

Paratypes: two males, same locality with dates September 4,

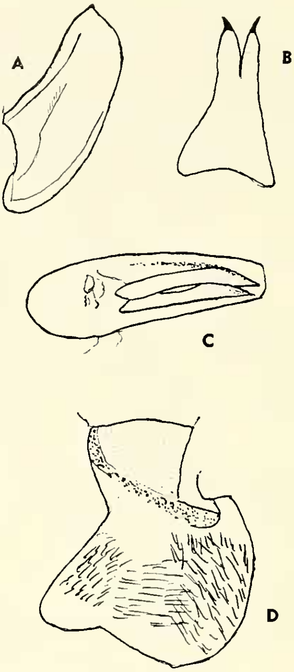

PLATE 16

Genitalia at *Eupithecia caxieri* n. sp.

A. Right clasper, B. ventral plate, and C. aedeagus of male genitalia. D. Female genitalia; ventral view of bursa.

1959 and August 21, 1957. Eight females, same locality, dates from September 1-8, 1959.

Holotype and allotype to be deposited in the Los Angeles County Museum, paratypes in the American Museum of Natural History, and in the collection of the author.

Named for my good friend Dr. Mont A. Cazier, Director of the Southwestern Research Station.

This species can most easily be separated from *misturata,* to which it bears a most remarkable likeness (especially in old or lightly marked specimens) by the brown band of segment II. On fresh specimens the fringe on the inner margin of *cazieri* appears to be much finer, with fewer coarse scales intermixed.

There seems to be no actual relationship to other members of the genus and for the present I am placing it in the *neomexicana-herefordaria* group, because of the general resemblance of the female genitalia.

EARLY COTTON INSECTS OF THE IMPERIAL VALLEY

E. A. McGREGOR
U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine[1]

In the early spring of 1916 the writer was assigned to the project of conducting a study of the cotton insects of the Imperial Valley. The observations covered a period of about three years. At the time of the studies this valley only recently had been reclaimed from a complete desert condition. Much interest attached to the problem of determining which insects had been able to invade cotton plantings during the brief period since 1909, when this crop was first planted commercially in this region.

An opportunity to record the insects occurring on a single commercial crop under such fascinating conditions is of rare occurrence, and the writer believes that the list of insects found on cotton in the Imperial Valley in that early period should be placed on record. The list is not presumed to be a complete inventory of all species present in cotton fields at the time, but it includes among many others, those insects that were of economic importance.

During a 2-day visit in the Imperial Valley (August 15-16, 1913), W. Dwight Pierce was able to recognize a total of 17 species of insects in cotton fields.

The taxonomic nomenclature followed herein is that in use at the time of the studies, or shortly thereafter. The identifications were made by taxonomists in the United States National Museum, and in the Bureau of Entomology. All material of interest was retained by the Museum. In instances where the term "not identified" is used, the specialists had placed the insect under the particular family, or the genus. In the case of certain species brief notations are included which bear on their economic importance, or their relative abundance. The list follows.

ARACHNIDA

Araneida

Numerous spiders, not identified.

ACARINA

Trombidiidae

Trombidium sp.

Euthrombidium sp. (Probably the most important predator attacking the field cricket (*Gryllus assimilis* (Fabr,) in cotton fields.)

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[1] Retired

Tetranychidae

Tetranychus bimaculatus Harv.
Tenuipalpus bioculatus McG.

ORTHOPTERA

Locustidae

Conozoa behrensi Sauss.
Melanoplus atlanis (Riley). Lesser migratory locust.
Orphulella compta Scudd. Green desert grasshopper.
Trimerotropis vinculata Scudd.
Other grasshoppers (not identified).

Gryllidae

Gryllus assimilis (Fabr.) Field cricket (McGregor, 1929). (A serious cotton pest.)
Miogryllus pictus (Scud.). A true cricket.
Oecanthus quadripunctatus Beut. (Both phytoghagous and predatory.)
O. nigricornis var. *argentinus* Sauss.
O. quadrinotatus Bent.

Mantidae

A mantid (Not identified).

ODONATA

Zygoptera

A damselfly (Not identified).

Anisoptera

A dragonfly (Not identified).

NEUROPTERA

Hemerobiidae

Hemerobius sp. Brown lacewing.

Sympherobiidae

Sympherobius sp.

Chrysopidae

Chrysopa californica Coq. (Often quite instrumental in controlling aphids on cotton.)
C. rufilabris Burm.

THYSANOPTERA

Thripidae

Microthrips piercei Morgan. (Very abundant, scarring the leaves of young cotton.)
Thrips tabaci Lind. Onion thrips.
Heliothrips fasciatus Perg. Bean thrips. (Occasionally destroying considerable portions of cotton plantings.)
Scirtothrips citri (Moult.). The citrus thrips.
Frankliniella gossypii (Morgan).
F. tritici (Fitch).
Anaphothrips tricolor Moult.

HOMOPTERA

Cicadidae

Cicada sp.

Membracidae

Ceresa occidentalis Funkh. Western treehopper. (Chiefly a pest of alfalfa, but common on cotton.)
C. uniformis Fair.
Stictocephala festina (Say). Three-cornered alfalfa hopper.
Campylenchia sp. Brown treehopper.
Other treehoppers, not identified.

Jassidae

Agallia uhleri Van D.
Helochara communis Fitch.
Draeculacephala mollipes Say. Sharp-headed leafhopper.
D. reticulata Sign. Yellow-headed leafhopper.
Gypona sp.
Empoasca sp.
Graphocephala versuta Say.
Chlorotettix sp.
Acinopterus acuminatus Van D.
Oecleus fulvidorsum Ball.
Oliarus sp.

Psyllidae

Aphalaria sp.

Aphididae

Aphis gossypii Glover. Cotton aphid. (One of ten worst cotton pests. In certain seasons, as in 1918, the infestation became very general and severe.)
Myzus persicae (Sulzer).

Coccidae

Pseudococcus sp. A mealy-bug.

Aleyrodidae

A whitefly, not identified.

HEMIPTERA

Pentatomidae

(Next to *Lygus elisus* Van D. (Miridae), the pentatomids, as a group, caused the greatest damage to cotton bolls. In 70 cotton fields the locks punctured by these bugs averaged 27.6 per cent.)

Brochymena tenebrosa Walker.
Chlorochroa sayi Stal. (Probably the most injurious of the pentatomids.)
Euschistus impictiventris Stal. Brown cotton bug. (One of the most serious pests of the cotton boll.)
Rhytidolomia uhleri Stal. (Punctures many bolls.)

Coreidae

Leptoglossus zonatus (Dallas). (This plant bug was shown by Fawcett (1929) to be a carrier of the disease-causing fungus, *Nematospora coryli* Peg., in the case of cotton bolls, citrus fruits, and pomegranates in the Imperial Valley.)

Corizidae

Corizus hyalinus (Fabr.)
C. lateralis (Say).

Lygaeidae

Geocoris punctipes Say. (An active predator of aphids and spider mites.)
Isthmocoris imperialis (Dist.).

Pyrrhocoridae

Dysdercus albidiventris Stal. A cotton stainer.
Euryophthalmus cinctus (H.-S.).

Tingidae

Corythucha sp.
Gargaphia iridescens Champ.

Phymatidae

Phymata erosa (Linn.). The jagged ambush bug. (Predaceous.)

Reduviidae

Atrachelus cinereus (Fabr.).
Sinea diadema Fabr. The spined soldier bug.
Zelus renardii Kolen.
Z. socius Uhler.

Nabidae

Nabis ferus (Linn.).

Anthocoridae

Triphleps tristicolor White. The dusky *Triphleps*. (Usually very numerous, attacking aphids, bean thrips, and spider mites.)
An anthocorid, not identified.

Miridae

Lygus elisus Van D. Western tarnished bug. (The writer (1927) appraised this to be the insect most injurious to cotton during the period of the investigations. Estimated damage to the 1918 crop was $1,280,000.)
Lygus pratensis (Linn.). The tarnished plant bug.
Psallus seriatus Reut. Western cotton-flea.
Rhinocloa forticornis Reut. An active enemy of spider mites and aphids, capable of devouring 60 mites per day.)
Reuteroscopus sp. (In cotton blossoms.)
Trigonotylus pulcher Reut.
A small, dark-colored bug resembling *Lygus*, not identified.

COLEOPTERA

Cicindellidae

Tetracha carolina (Linn.).
A cicindellid, not identified.

Carabidae

Calosoma triste Lec. (Attacks various caterpillars.)
A carabid, not identified.

Silphidae

A silphid beetle, not identified.

Staphylinidae

A black and green staphylinid, not identified.
A rufous staphylinid, not identified.

Lampyridae

A lampyrid beetle, not identified.

Malachiidae

Collops marginellus Lec.
C. punctulatus Lec.

Meloidae

Epicauta puncticollis (Mann.).
A meloid beetle, not identified.

Anthicidae

Anthicus vividus Cay.
Notoxus alamedae Cay.
An ant-mimicing anthicid, not identified.
A brown anthicid beetle, not identified.

Elateridae

Drasterius livens Lec. (This wireworm occasionally was of serious economic importance to seedling cotton on new land.)
Stenopodius flavidus Horn. Malva miner.

Buprestidae

Acmaeodera sp.

Coccinellidae

Cycloneda munda (Say).
Hippodamia convergens Guer. Convergent ladybettle. (This insect's importance in the control of aphids in the Imperial Valley was greatly exaggerated. Critical studies of grain fields in which millions of this ladybeetle were liberated, showed the average census of *H. convergens* to be two per acre, and of aphids, 25,370,000 per acre. Eight syrphids, six small coccinellids, *Triphleps, Geocoris, Chrysopa* spp., reduviids, and internal parasites were much more effective against aphids.)
Hyperaspis sp.
Megilla maculata De G.
Olla abdominalis (Say).
Paranemia maculata (Deg.)
Scymnus marginicollis Mann. (Tests revealed that 3rd instar larvae of this ladybeetle consumed an average of 23 cotton aphids per day.)
S. apacheanus Casey.
S. ardelio Horn.
S. nubes Casey.

Tenebrionidae

Blapstinus sp. Darkling ground beetle.
Cryptoglossa verrucosa Lec.

Chrysomelidae

Chaetocnema ectypa Horn. Desert flea-beetle.
Deloyala clavata Fabr.
Diabrotica duodecimpunctata var. *tenella* Lec. 12-spotted cucumber beetle.
D. trivittata (Mann). Western striped cucumber beetle.
Disonycha 5-vittata (Say).
Epitrix parvula Fabr. Tobacco flea-beetle.
Myochrous longulus Lec. (The writer (1917) reported a severe outbreak of this beetle south of Yuma on seedling cotton.)
Systena taeniata (Say). Pale banded flea-beetle.
S. taeniata var. *blanda*. Melsh.
Trirhabda sp.
Metachroma californicum Cr.
A minute fuscous chrysomelid, not identified.

Bruchidae

Mylabris prosopis (?) Lec.

Curculionidae

Dinocleus molitor Lec.
A weevil (near *Anthonomus*).

Anobiidae

Catorama vestitum Fall.

Lagriidae

Statira defecta Schffr.

Mordellidae

Anaspis pusio Lec.
Pentaria nubila (Lec.).

DIPTERA

Syrphidae

Allograpta fracta O. S.
A. obliqua (Say).
Catabomba pyrastri Linn.
Eupeodes volucris O. S.
Mesograpta geminata (Say).
Paragus bicolor (Fabr.).
Syrphus americanus Wied.
S. nitens (Zett.).

Culicidae

Species of mosquitoes, not identified.

Asilidae

An asilid, not identified. Robber fly.

Phoridae

Aphiochaeta sp. (Reared from cotton square-borer, *Uranotes melinus* (Hbn.).

Tachinidae

Frontina frenchii Will. (Reared from salt marsh capterpillar, *Estigmene acraea* (Drury)).

A tachinid, not identified.

Sarcophagidae

Sarcophaga opifera Coq. (A parasite of *Melanoplus atlanis* Riley.)

S. helicis Tns.

Oscinidae

Meromyza americana Fitch. (Captured by sweeping in cotton fields.)

An oscinid, not identified.

Agromyzidae

Agromyza scutellata Fall. The serpentine leaf-miner.

A. sp., near *minima* Mall.

Desmometopa n. sp.

Menoneura vagans Fall.

Ochthiphilidae

Leucopis griseola Fallen. (Reared from syrphid puparium in colony of *Aphis gossypii.*)

Trypetidae

Eutreta diana O. S.

Bombyliidae

Mythicomyia scutellata Coq.

LEPIDOPTERA

Eurymus eurytheme (Bdv.) Alfalfa caterpillar. (Extremely abundant at times.)

Lycaenidae

Uranotes melinus Hbn. The cotton square-borer. (The phorid fly, *Frontina frenchii* Will., was reared from this lycaenid.)

Noctuidae

Alabama argillacea ? (Hbn.). The cotton leaf worm. (Material was not identified as this species, but the writer believes that it was seen on a few occasions.)

Plusia sp. (This looper was occasionally seen boring into cotton squares.)

Heliothis obsoleta (Fabr.). The cotton bollworm. (This insect probably ranked as one of the six worst cotton pests during the period of the studies.)

Laphygma exigua ? (Hbn.). The beet armyworm.

Prodenia ornithogalli Guen. The cotton cutworm. (Occasionally destroyed many seedling cotton plants.)

Geometridae

A measuring worm, not identified.

Pyralidae

Loxostege sp. A webworm.

Gelechiidae ?

An inter-carpel miner. (A lepidopterous larva was seen occasionally tunneling along the inner walls of the carpels of cotton bolls. A similar larva was observed in Sonora, Mexico.)

Lyonetiidae

Bucculatrix thurberiella Busck. The cotton leaf-perforator (McGreor 1916). (During the period of the studies this insect ranked about tenth in importance as a cotton pest. Damage by it was limited mainly to plantings suffering from drouth or alkali. Two species of chalcidid flies, and one pteromalid fly were reared from pupae of *Bucculatrix,* the parasitism being at times as high as 80 percent. See below.)

HYMENOPTERA

Braconidae

Lysiphlebus testaceipes (Cress.). (Reared from *Aphis gossypii* Glov.)

Apanteles n. sp.

A braconid, not identified.

Ichneumonidae

An ichneumonid, not identified.

Pteromalidae

Arthrolytus aeneoviridis Gir. (Reared on numerous occasions from *Bucculatrix thurberiella* Busck.)

Trigonogastra aurata Ashm.

Chalcidae

Two chalcidids, not identified. (Reared from pupae of *Bucculatrix thurberiella* Busck.)

Scelionidae

Scelio ? sp. (Reared from eggs of the true cricket, *Gryllus assimilis* (Fabr,).)

Formicidae

Pogonomyrmex californicus (Buck.). The California harvester ant. (Frequently accused in the Imperial Valley of stinging to death new-born pigs.)

A small red ant, not identified.

Chrysididae

A cuckoo wasp, not identified.

Bethylidae

Epyris sp.

Mutillidae

A velvet ant, not identified.

Pompilidae

A spider wasp, not identified.

Vespidae

Polistes sp.

Vespa sp. Yellow-jacket ?

Polybia ? sp.

Apidae

Apis mellifica Linn. The honey bee.

An aphid-bee .(Frequenting cotton leaves coated with honeydew of the cotton aphis.)

Halictidae

Halictus sp.

Entedontidae

Closterocerus utahensis Cwft.

Eulophidae

Paragaleopsomyis gallicola Gahan.

Eurytomidae

Eurytoma medicaginis Gahan.

Encyrtidae

Rileya cecidomyiae Ashm.

Callimomidae

Callimome sp.

Summary: It is here shown that 191 species in 84 insect families were collected in cotton plantings in the Imperial Valley during the period 1916-1918. These fields had been in cotton only from 1 to 7 years, and the entire valley had been opened to agriculture for only a very brief period previously.

The vast majority of the insects reported herein had doubtless occurred originally in the general area on the native plants. The data reveals the remarkable ability of this great variety of insects to transfer, for one reason or another, to a single species of plant, foreign to their experience in the area.

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CORRIGENDUM: Vol. 59, page 180, 12th line from top, under *G. arizonensis,* strike out line reading "less tendency to gregariousness."

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CONTENTS

Issued August 31, 1961

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CLARENDONIAN INSECTIVORA FROM THE RICARDO FORMATION, KERN COUNTY, CALIFORNIA

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ABSTRACT

Two new insectivores of middle Clarendonian age are described from the upper part of the Ricardo formation, Kern County, California. Both species seem closely related to living North American representatives of their respective subfamilies. A soricine shrew, *?Hesperosorex chasséae,* is represented by jaw fragments showing the complete lower dentition. These remains closely resemble the jaws and lower dentition of the living and fossil species of *Notiosorex* suggesting an ancestor-descendant relationship.

Also represented by lower jaw fragments is a scalopine mole, *Scapanus shultzi,* the earliest record of the genus. *Scapanus shultzi* seems most closely related to the hypsobrachyodont living species, *S. orarius* and *S. towsendii,* but could conceivable be ancestral to the hypsodont *S. latimanus* and even *Scalopus* (via the Blancan *Hesperoscalops*) as well.

Domninoides Green, 1956 is shown to be a talpid and not a soricid. It may be more closely allied to *Parascalops* than to the advanced scalopines such as *Scapanus.*

INTRODUCTION

Knowledge of the Clarendonian Insectivora of western North America has been very meager to date, essentially limited to a single locality, Fish Lake Valley, Nevada. The best known Fish Lake Valley insectivorans are two genera of erinaceids, *Metechinus* and *Meterix.* The Soricidae are represented solely by the genus *Mystipterus* known from a jaw fragment with the last lower molar.

Careful prospecting of the Ricardo formation in recent years has brought to light a variety of small mammal remains. All of these new discoveries come from the upper portion of the Ricardo formation associated with an assemblage of larger mammals of approximately mid-Clarendonian age.

Talpid remains have been collected from two localities near the top of member 6 of the Ricardo formation as defined by Dibblee (1952). Associated mammalian remains at this horizon include sciurid, geomyid, *Hypolagus* sp., *Tomarctus robustus* (holotype), *Vulpes* sp., felid, *Pliohippus* sp., *Hipparion* cf. *mohavense, Ustatochoerus* cf. *californicus, Merycodus* sp., and *Sphenophalos* sp.

Soricine shrew mandibles representing two individuals were collected from a quarry (Chassé Quarry, L.A.C.M. locality 1553) at the base of member 7 of the Ricardo formation (Dibblee, 1952) at a stratigraphic position very nearly equivalent to the horizon producing the talpid remains. Members 6 and 7 are in part facies of one another hence the approximate equivalence in stratigraphic position. Associated mammals from Chassé Quarry include sciurid, *Perognathus* sp., *Peromyscus* sp., *Aelurodon aphobus, Osteoborus* cf. *diabloensis,* mustelid, *Pliohippus* cf. *tantalus, Ustatochoerus* cf. *californicus,* camelids, and *Merycodus* sp.

I am indebted to Drs. R. A. Stirton, T. Downs, M. C. McKenna and W. A. Clemens for their criticism of the manuscript in its preliminary form, and to Messrs. Owen J. Poe and Karoly Fogassy for their careful illustration of the material (their individual contributions are acknowledged in the figure legends). Drs. Seth B. Benson (Museum of Vertebrate Zoology, University of California, Berkeley), Charles A. McLaughlin (Los Angeles County Museum), and Rudolfo Ruibal (Division of Life Sciences, University of California at Riverside) loaned Recent insectivore material under their care.

A special debt of gratitude is owed to Mr. Robert L. Shultz, Jr., Miss Beth H. Chassé, and Mr. Sherwood D. Mayall for their enthusiastic assistance in the field. They are primarily responsible for the discovery of the insectivore material reported in this work.

This study was assistd by Intramural Grant 2085 from the University of California at Riverside.

The abbreviation "U.C.M.P." refers to material in the University of California Museum of Paleontology collections; "L.A. C.M." to collections of the Los Angeles County Museum. All measurements are in millimeters.

SYSTEMATIC DESCRIPTIONS

Class MAMMALIA

Order INSECTIVORA

Family Soricidae Gray, 1821

Subfamily Soricinae Murray, 1866

?Hesperosorex chasséae[1], n. sp.

HOLOTYPE.—L.A.C.M. 4264 right mandibular fragment with the complete dentition, but lacking the ascending ramus. Teeth in early wear. Plate 14.

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[1] For Miss Beth H. Chassé whose careful collecting in the Ricardo deposits yielded the type materials of this shrew and many other valuable fossil remains.

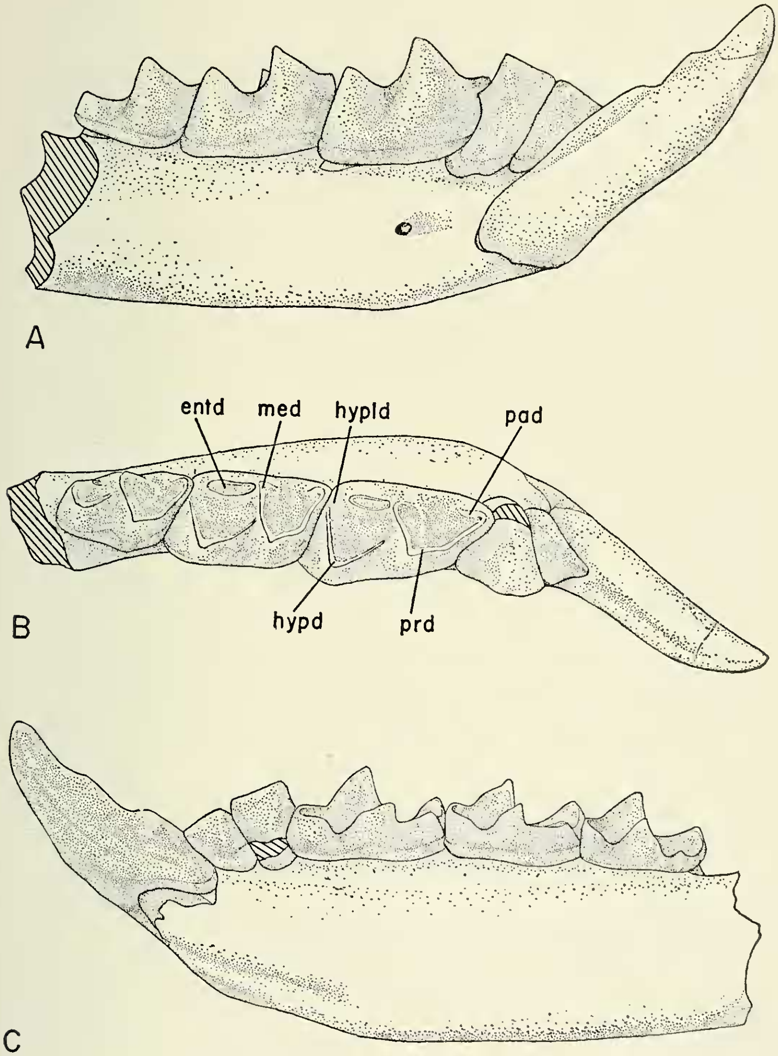

PLATE 14

?Hesperosorex chasséae, holotype right mandible, L.A.C.M. 4264, approx. × 16. A. labial, B. occlusal, C. lingual views. Abbrevations: entd, entoconid; hypd, hypoconid; hypld, hypoconulid; med, metaconid; pad, paraconid; prd, protoconid. Figure by Karoly Fogassy.

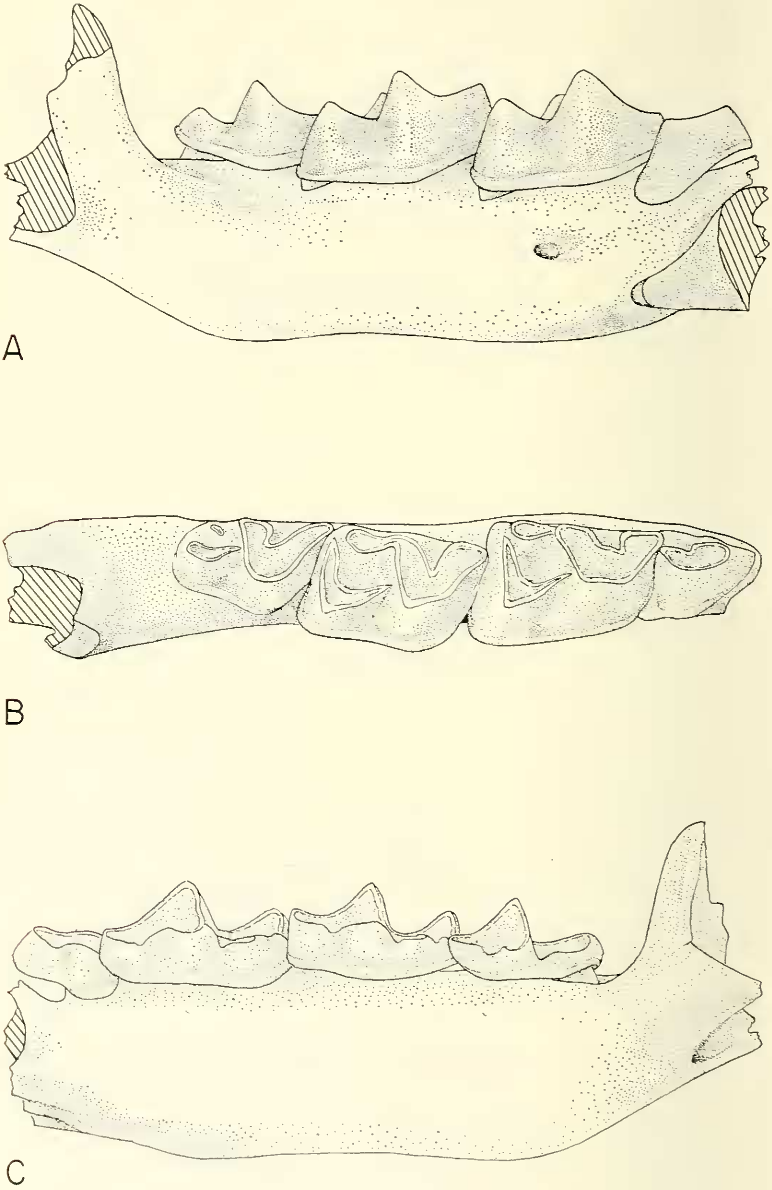

PLATE 15

?Hesperosorex chasséae, paratype right mandible, L.A.C.M. 4265, approx. × 18. A Labial, B. occlusal, C. lingual views. Figure by Karoly Fogassy.

PARATYPE.—L.A.C.M. 4265 right mandibular fragment showing the base of the ascending ramus but lacking the P/1 and most of the incisor, P/4 M/1-3 complete showing moderate wear. Plate 15.

TYPE LOCALITY.—The holotype and paratype were collected at Chassé Quarry, L.A.C.M. locality 1553, in buff sandy siltstones with caliche lenses near the base of member 7 of the Ricardo formation (Dibblee, 1952), about 1.2 miles northwest of Ricardo, grid coord. 1,299,850-1,384,250 yds., Saltdale Quadrangle, 1:62,-500, Corps Eng., U. S. Army, edition 1943.

AGE.—Middle Clarendonian.

DIAGNOSIS.—Smaller than *Hesperosorex lovei* about the size of *Notiosorex crawfordi;* lower molars with entoconids relatively stronger than in *H. lovei,* entoconid of M/2 as close to posterior base of metaconid as in M/1; lacks well developed anteriolabial cingula on M/1-2.

DESCRIPTION.—Size of jaw teeth about that of *Notiosorex crawfordi.* Traces of yellow pigment are retained on the tips of the incisor and protoconid of M/1. The presence of pigment on the tips of the premolors and protoconids of M/2-3 is suggested by their response when exposed to ultraviolet light.

The lower incisor is long, its unworn dorsal surface possesses two lobes, the posterior lobe relatively larger than the anterior. The angle made by the incisor relative to the axis of the lower jaw in the holotype is distorted due to crushing of the anterior part of the jaw in that specimen. The undistorted base of the incisor in the paratype indicates that the orientation of the long axis of this tooth was similar to that of *Notiosorex.*

The FIRST PREMOLAR[1] is present only in the holotype, somewhat crushed between the distorted incisor and fourth premolar. It overlaps the dorsal base of the incisor with a strong anterior projection of the crown. Its labial cingulum is very low.

The FOURTH PREMOLAR is somewhat distorted in the holotype, but is well preserved, although more heavily worn, in the paratype. It is larger than the P/1 with a strong anterior projection of the crown and a crest emanating from the major cusp and passing posteriorly to the posterolingual corner of the tooth. This crest is concave lingually forming a shallow basin in the posterolingual portion of the crown. This basin is quickly eliminated through wear, but at the state of wear of the paratype it is still visible as a reentrant in the posterolingual border of the crown. There is a low labial and lingual cingulum on P/4.

---

[1] The dental formula follows that proposed by Arnbäch-Christie-Linde (1912).

The FIRST MOLAR is the largest tooth in the molar series. It is lower crowned than in the Pleistocene or Recent species of *Notiosorex*. The trigonid is only slightly narrower than the talonid, its metaconid and paraconid are more widely separated than in the other molars giving the trigonid a more open appearance. The paraconid and metaconid both have ridges extending into the lingually open trigonid valley. The entoconid is well developed and strongly attached to the posterior base of the metaconid closing the talonid valley lingually. A notch separates the posterior end of the entoconid from the hypoconulid. The hypoconulid is located at the end of the lingually projecting crest from the hypoconid which makes up the posterior rim of the talonid. A crest from the hypoconid passes anteriolingually to the posterior base of the protoconid. The labial and lingual cingula are well differentiated but low. There is no prominent development of the anterolabial cingulum.

The SECOND MOLAR is much like the first in general morphology. It is somewhat smaller and its trigonid and talonid are of approximately equal width. The paraconid and metaconid are set closer together giving the trigonid a more compressed appearance. The configuration of the crown is otherwise much as in M/1. The labial cingulum is somewhat better developed, particularly anteriorly.

The THIRD MOLAR is the smallest molar. The configuration of its trigonid is like that in M/2. Its talonid is reduced, the hypoconid and a crest leading to the posterior base of the protoconid make up the bulk of the heel. A tiny entoconid is present close to the metaconid and just above the lingual cingulum. The labial cingulum is somewhat better developed than in M/2 although it is no more expanded anteriorly than in the latter tooth.

The jaw is fairly deep for the size of the tooth row, a single mental foramen occurs beneath the M/1. The anterior margin of the mental foramen is slightly depressed. Only a portion of the ascending ramus is preserved in the paratype. This specimen shows that the mandibular foramen lies in a groove at the base of the ascending ramus below the posterointernal ramal fossa.

COMPARISONS.—Of the described Tertiary genera of Soricinae only the Hemphillian *Hesperosorex* Hibbard, 1957, is close enough to the Ricardo fossil to warrant detailed comparison. Unfortunately, complete comparison between the genotype *H. lovei* and *?H. chasséae* cannot be made due to the lack of the anterior dentition and M/3 in the former and the lack of much of the ascending ramus in the latter.

Hibbard defined the genus *Hesperosorex* on the large size of the entoconid and its relative proximity to the metaconid on M/1-2. These features are also characteristic of the presently described species. The Ricardo fossil is slightly smaller than *H. lovei* (see Table I) and differs in lacking well developed anteriolabial cingula

TABLE I

Measurements of the Molar Dentition and Jaw of *Hesperosorex*

		?*Hesperosorex chasséae* Holotype	?*Hesperosorex chasséae* Paratype	*H. lovei*[1]
M/1	Length	1.47	1.40	1.58
	Width trigonid	0.75	0.82	0.95
	Width talonid	0.85	0.84	1.03
M/2	Length	1.29	1.35	1.40
	Width trigonid	0.76	0.83	0.90
	Width talonid	0.78	0.82	0.93
M/3	Length	1.05	1.11	-
	Width trigonid	0.67	0.72	-
	Width talonid	0.53	0.57	-
Depth jaw below M/1 externally		-	1.31	1.50

1.) Measurements courtesy of D.W. Taylor, U.S. National Museum

on M/1-2. The entoconids appear stronger than in *H. lovei* and the entoconid on M/2 is as close to the base of the metaconid as its homologue on M/1. Hibbard did not describe the condition of the mandibular foramen in *H. lovei.* I am questionably referring the Ricardo jaws to *Hesperosorex* on the basis of their close correspondence with the genotype in such features as can be compared. Further discussion of the generic assignment of *?H. chasséae* is presented below.

?Hesperosorex chasséae was compared with the following living North American genera: *Blarina, Cryptotis, Microsorex, Notiosorex,* and *Sorex.*

Sorex and *Microsorex* are at once eliminated from further comparison by their more massive premolars, more open molar trigonids, and retention of a strongly bicuspidate talonid on M/3. What is known of the Clarendonian soricine *Mystipterus* allies it with shrews possessing little reduced M/3 talonids such as the foregoing living genera. It cannot be further compared with *?H. chasséae.*

Blarina brevicauda is larger than *?H. chasséae,* but about the same size as *H. lovei.* The tip of its lower incisor is more strongly procumbent than in *?H. chasséae.* Its lower molars make a more strongly graduated series with the M/1 much larger relative to M/3 than in *?H. chasséae.* In the lower molars of *Blarina* the trigonids are more open lingually, the entoconid is separated by a deep groove from the metaconid in M/1-2. The talonid of M/3 is crescentic and lacks the entoconid.

Cryptotis parvus is smaller than *?Hesperosorex chasséae* and differs from the Ricardo shrew in the same way as does *Blarina.* The M/3 is more reduced relative to M/1 than in *?H. chasséae,* its talonid is reduced to a single cusp (the hypoconid). The trigonids of M/1-2 are more open lingualy than in *?H. chasséae,* and the talonids of these molars open lingually through a deep notch between the metaconid and entoconid.

The Ricardo shrew makes a closer approach to species of the genus *Notiosorex* than to any other living genus of Soricinae. The three specimens of *N. crawfordi* available to me for comparison come from widely separated localities (L.A.C.M. 5051, ♀, from Ventura County, California, L.A.C.M. 6065, ♀, from Hidalgo County, Texas, and L.A.C.M. 8429, ♂, from Cabo San Lucas, Baja, California). These specimens show considerable intraspecific variation in dental characters with some individuals making a remarkably close approach to the conditions in *?Hesperosorex chasséae.* The specimen from Texas is noteworthy in this regard.

The unworn incisor is more massive, particularly at the tip in *Notiosorex* and does not bear the conspicuous two lobed dorsal surface as in *?H. chasséae.* The premolars are larger relative to the molars in *Notiosorex.* The molars of *?H. chasséae* are definitely lower crowned than in any of the specimens of *N. crawfordi,* and their anteriolabial cingula less well developed. The M/3 is not as reduced relative to the anterior molars in *?H. chasséae,* its trenchant talonid still retains a tiny entoconid. The latter cusp was not observed in the M/3 of *Notiosorex,* but a lingual shelf is present where the entoconid should be. The Texas representative of *N. crawfordi* shows the greatest development of this shelf and also the least reduction of the M/3 relative to the anterior molars. In morphology of the molar trigonids the two genera are closely similar. The talonids of M/1-2 differ only in the strength of the entoconid. In the California and Baja California representatives of *N. crawfordi* the entoconid on M/1-2 is small and distinctly separated by a deep notch from the metaconid. In these specimens a somewhat shallower notch may (California) or may not (Baja California) separate the entoconid from the hypoconulid. The entoconid is a much larger cusp in the individual from Texas closely approaching the condition held typical of *Hesperosorex.* In the

Texas example the entoconid is separated from the hypoconulid by a shallow notch and is connected to the metaconid by a strong ridge thus closing the talonid valley.

Hibbard (1950, 1953) does not discuss the morphology of the entoconid in the M/1-2 of *N. jacksoni,* but from his figures (especially 1953, fig. 5A) that cusp appears to be well developed and connected to the metaconid much as in the Texas specimen of *N. crawfordi* described above.

?Hesperosorex chasséae lacks the postalveolar process of *Notiosorex,* and has a prominent groove leading anteriorly into the mandibular foramen which is lacking in *Notiosorex.*

A comparison of *?H. chasséae* with the Oligocene soricine *Domnina gradata* as described and illustrated by Patterson and McGrew (1937) is instructive. The two forms differ greatly in the number of premolar teeth. *D. gradata* has the full eutherian premolar formula whereas in *?H. chasséae* this is reduced to two premolars as in living soricines. The lower incisor of *?H. chasséae* is much enlarged over the condition in *D. gradata.*

In the lower molars, however, we see a closer resemblance between the two species. Although *D. gradata* is larger there is little difference in relative crown height of the molars. The lower molars of *Domnina gradata* have decidely better developed labial cingula than in *?H. chasséae.* The molar trigonids are rather similar except that the protoconid is sharply angulate labially in *D. gradata.* The hypoconids of M/1-2 are also more sharply angulate labially in *D. gradata,* but otherwise the talonids of these teeth closely resemble those of *?H. chasséae,* including the presence of a large entoconid strongly connected to the metaconid and enclosing the talonid basin lingually. The entoconid on M/3 in *D. gradata* is either absent or reduced to a low ridge. It is present as a tiny, but distinct, cusp in *?H. chasséae.*

Domnina is a primitive soricine and some of its species may be structurally ancestral to such later Tertiary genera as *Hesperosorex.* Whether they are in fact ancestral depends on much more evidence than presently available. The above comparison serves to demonstrate the possibility of such a phylogeny and shows that the morphological plan of the molars of *Hesperosorex* is present in the Oligocene.

Discussion.—From the foregoing comparisons it seems clear that *?Hesperosorex chasséae* is closely related if not actually ancestral to *Notiosorex.* Some of the morphological changes in the lower jaw and dentition leadng from *?H chasséae* to *Notiosorex* would involve an increase in height of crown of the post-incisor teeth, development of more massive lower incisors, reduction of the size of M/3 relative to M/1, loss of the entoconid on M/3 and reduction in the size of this cusp in M/1-2, enlargement of the anterior cingula on the molars, enlargement of the post-alveolar process and probable change in the ascending ramus.

A mandibular condyle like that in *Hesperosorex lovei* could easily be transformed into that characteristic of *Notiosorex* by enlargement of the superior articulation. The other described and figured features of the ascending ramus in the Hemphillian species do not differ radically from *Notiosorex*.

The validity of the genus *Hesperosorex* cannot rest exclusively on the large size of the entoconids and their proximity to the metaconids on M/1 and M/2 as originally diagnosed. The characters are definitely possessed by some individuals of *Notiosorex crawfordi*. They appear to be primitive characters in the Soricinae as evidenced by the development of these cusps in *Domnina*. The diagnosis of *Hesperosorex* should also include the condylar characters of *H. lovei*.

It could be argued that *?H. chasséae* might be better referred to *Notiosorex* itself. However, the above comparisons of *?H. chasséae* with *Notiosorex* demonstrates greater morphological separation than exists among the presently recognized species of *Notiosorex* (*N. crawfordi* and *N. jacksoni* excluding *N. gigas* made the type of a new genus, *Megasorex* Hibbard, 1950). For this reason the Ricardo shrew has been referred to its nearest Tertiary ally, *Hesperosorex*, despite the fact that satisfactory comparison of *?H. chasséae* and *H. lovei* is not possible at the present time. The questionable generic assignment serves to emphasize the uncertainties involved.

Family Talpidae Gray, 1825

Subfamily Scalopinae Thomas, 1912

Scapanus shultzi[1], n.sp.

Holotype. — U.C.M.P. No. 46646; right mandibular fragment with P/4 and M/1-3 complete, root of P/2, and alveoli for C, P/1 and P/3. Ascending ramus broken away behind anterior edge of the masseteric fossa. Teeth present show moderate wear. Plate 16.

Type locality. — U.C.M.P. locality V5376, fine grained gray sandstones and sandy siltstones, uppermost part of member 6 of the Ricardo formation (Dibblee, 1952), north end of the badland cliffs about 1/3 mile west of Ricardo, Kern County, California,

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[1] For Mr. Robert L. Shultz, Jr., in appreciation of his comradeship and invaluable assistance in the field over the course of several years.

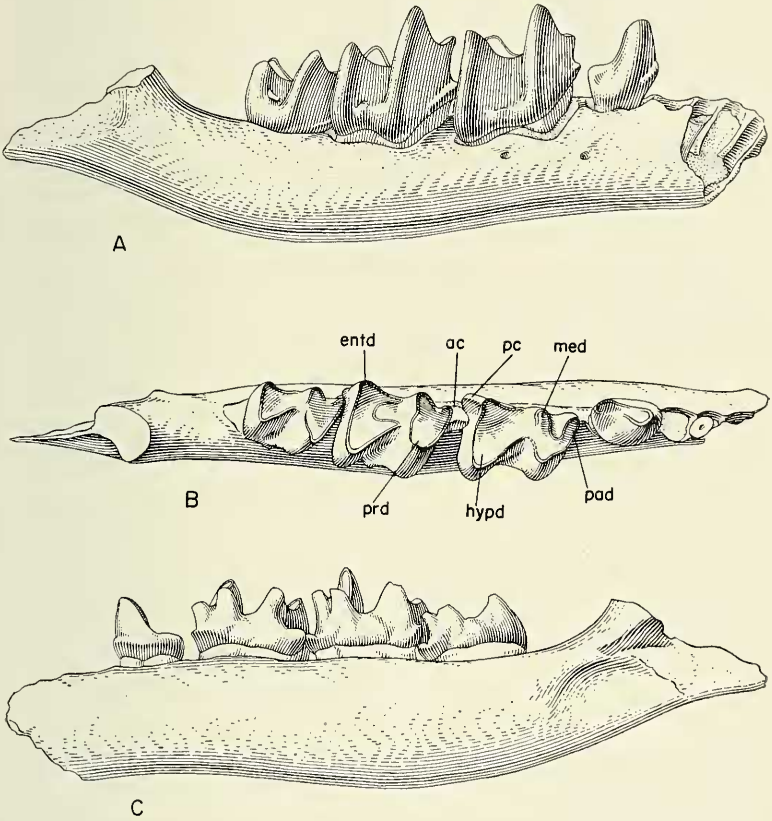

PLATE 16

Scapanus shultzi, holotype right mandible, U.C.M.P. 46646, approx. × 7.5. A. labial, B. occlusal, C. lingual views. Abbrevations: ac, anterolingual cingular cusp; entd, entoconid; hypd, hypoconid; med, metaconid; pad, paraconid; pc, posterolingual cingular cusp; prd, protoconid. Figure by Owen J. Poe.

at approximately grid coordinates 1,298,500-1,382,300 yds., Saltdale Quadrangle, 1:62,500, Corps Eng., U. S. Army, edition 1943.

A fragment of a right humerous, U.C.M.P. 35320, broken proximally above the teres tubercle and distally lacking the wings of the lateral epicondyle and medial epicondyle, was collected in 1937 by a University of California party from buff tuffaceous sandstones in the uppermost part of member 6 of the Ricardo formation (Dibblee, 1952), at approximately the same stratigraphic position as the holotype of Scapanus shultzi. The locality, U.C.M.P. V3732, site 2, is approximately 500 yards east of the old segment of Highway 6, opposite the junction with the Dove Springs road, grid cord. 1,296,000-1,393,900 yds., Saltdale Quadrangle, 1:62,500, Corps Eng. U. S. Army, edition 1943.

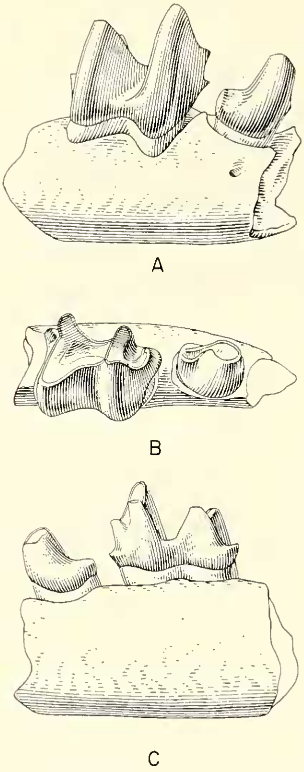

PLATE 17

Scapanus shultzi, referred right mandibular fragment, U.C.M.P. 29281, approx. × 7.5. A. labial, B. occlusal, C. lingual views. Figure by Owen J. Poe.

AGE. — middle Clarendonian.

REFERRED SPECIMENS. — A fragment of a right ramus containing P/4 and M/1, U.C.M.P. 29281 (Plate 17), was obtained from the Ricardo formation by a University of California party in 1913. This specimen comes from an unknown horizon apparently within the upper part of the Ricardo formation. The state of wear of the dentition approximates that of the holotype.

DIAGNOSIS. — Fourth premolar double-rooted with well developed posterior cingular shelf. Molars with cuspidate labial cingula between protoconid and hypoconid, antero- and posterolingual cingular cusps better developed than in other species of the genus.

DESCRIPTION. — Size of the holotype mandible and dentition about that of *Scapanus orarius.* Four alveoli or parts of alveoli lie anterior to the last premolar. The symphyseal articulation lies opposite the anteriormost alveolus and identifies this alveolus as that of the canine by analogy with living talpids. Post-canine dental formula: P/1.2.3.4., M/1.2.3. The canine and anterior premolar alveoli are slanted anteriorly, the premolar alveoli gradually becoming vertical posteriorly. Alveoli indicate that the canine and P/1 to P/3 are single-rooted, and have the following size relationship: $P/4 > P/3 \geq P/1 > P/2 > C$. *P/4:* Double-rooted (confirmed by X-ray examination) with a high conical crown, its principal cusp slightly lower than the protoconid of M/1 at this state of wear. It bears a small anterolingual cingular cusp and a well developed posterolingual cingular cusp. *M/1:* This tooth is only slightly smaller than M/2. The anterolingual cingular cusp is present, but it is smaller than its homologue on M/2. The posterolingual cingular cusp is well developed and larger than on M/2. The trigonid is more open than on the succeeding molars and of relatively lesser width. Ridges from the entoconid and hypoconid to the metaconid have coalesced to form a broad union with the posterior base of the metaconid at this state of wear. The labial cingulum between the protoconid and the hypoconid lacks the median cuspule present on M/2 or M/3. *M/2:* The largest molar; its anterolingual cingular cusp is shelf-like, and approximately twice the size as the same cusp on M/1. This cusp is overlapped anteriorly by the posterolingual cingular cusp of M/1. The posterolingual cingular cusp is approximately half the size of, and narrower than, its counterpart on M/1. The trigonid is approximately as wide transversely as the talonid, but is more strongly compressed antero-posteriorly than in M/1. Ridges from the entoconid and hypoconid extend to the base of the metaconid as in the M/1, and at this state of wear these ridges enclose the talonid basin. The labial cingulum possesses a well developed cuspule situated somewhat nearer the hypoconid than the protoconid. *M/3:* Approximately three-quarters the size of M/2. The anterolingual cingular cusp is larger than same cusp on M/1, but smaller than that on M/2, it is overlapped anteriorly by posterolingual cingular cusp of M/2. No posterolingual cingular cusp is present. The trigonid is wider transversely than the talonid, and not so compressed antero-posteriorly as in M/2. The labial cingulum has a well developed cuspule attached to anterolabial base of the hypoconid. Two mental foramina are present in the holotype. The anterior foramen is the largest, situated between P/4 and M/1, and the posterior foramen the smaller, situated near the alveolar border below the middle of M/1. The mandible is shallow with a pronounced convexity of the inferior border below M/3. For measurements see Table II.

The referred jaw fragment represents an individual having a slightly larger horizontal ramus than the holotype. *P/4:* X-ray examination shows that the roots of this tooth are fused for 2/3 of their total length below the base of the crown. The crown is high and conical, its main cusp slightly lower than the protoconid of M/1 at this state of wear. The anterolingual cingular cusp is relatively smaller than in the holotype, but its posterolingual cingular cusp is as well developed as in the holotype. *M/1:* Slightly larger than the same tooth in the holotype with the anteriolingual cingular cusp as well developed as in the latter. Its paraconid is relatively smaller than in the holotype, giving the trigonid a more compressed appearance. Ridges from the entoconid and hypoconid to the posterior base of the metaconid have nearly coalesced to form a broad union with metaconid in this state of wear. The labial cingulum is represented by only two tiny cuspules on the bases of the protoconid and hypoconid. The mental foramen lies below P/4; there is no foramen below M/1.

It is impossible to determine the stratigraphic position of the referred jaw fragment relative to that of the holotype. Larger size, partial fusion of the roots of the P/4, and the reduced antero- and posterolingual cingular cusps on the M/1 suggest closer approach to the living species of *Scapanus.*

TABLE II

Measurements of the Dentition and Jaw of Scapanus shultzi

		Holotype	Referred Specimen
		U.C.M.P. 46646	U.C.M.P. 29281
P/4	Length	1.24	1.31
	Width	0.82	0.90
M/1	Length	2.08	2.36
	Width trigonid	1.20	1.55
	Width talonid	1.47	1.83
M/2	Length	2.25	-
	Width trigonid	1.54	-
	Width talonid	1.58	-
M/3	Length	1.69	-
	Width trigonid	1.13	-
	Width talonid	0.92	-
Depth	jaw below M/1 externally	1.6	2.0

The humerus fragment is smaller than specimens of *Scapanus latimanus* available for comparison, although it displays a marked similarity in the parts preserved. It differs chiefly in being relatively narrower across the shaft; in having a broader notch between the medial epicondyle and the trees tubercle, a feature correlated with a less expanded teres tubercle; and in possessing a relatively larger and more ventral opening of the entepicondylar foramen.

The Ricardo fossil greatly resembles the slightly larger humerus described by Gregory (1942) from the Big Spring Canyon local fauna. ?*Talpa platybrachys* Douglass from the Barstovian Flint Creek local fauna represents a larger animal whose humerus possesses a relatively longer and narrower shaft. ?*Scapanus* sp. described by Merriam (1911) from the Hemphillian Thousand Creek local fauna makes a much closer approach in size and morphology to the humerus of living species of *Scapanus* than does the humerus referred to *S. shultzi*. The only difference is that the teres tubercle is somewhat smaller in the Hemphillian form.

Comparisons. — The following materials were available for comparison in the University of California Museum of Vertebrate Zoology: *Scapanus latimanus* (Bachman), *S. orarius* (True), and *S. townsendii* (Bachman).

The living species of the genus *Scapanus* may conveniently be separated into two groups based on the height of crown of their molar teeth. The molars in the genotype, *S. townsendii*, and *S. orarius*, are hypsobrachyodont whereas *S. latimanus* possesses hypsodont teeth (high crowned teeth whose crown bases lies below the alveolar border in early wear, essentially the "cusp hypsodonty" of White (1959). *Scapanus shultzi* is hypsobrachyodont and shares many characters with the species of that group, yet it also shows definite affinity with the hypsodont *S. latimanus*.

The P/4 of *S. shultzi* is distinguished from all the species of *Scapanus* by its double-rooted condition and large posterior cingular shelf.

Scapanus shultzi is smaller than *S. townsendii*. The lingual and labial cingular cusps on the molars are better developed in the fossil species. The molars are relatively longer for their width in *S. townsendii* due to the greater separation of trigonid and talonid cusps, yet the trigonid cusps are compressed, making a closely knit triangle as in *S. shultzi*. The M/1 has a low anterolingual cingular cusp in *S. townsendii*.

Scapanus orarius is similar in size to *S. shultzi*. The labial and lingual cingular cusps are somewhat better developed in *S. shultzi*, but *S. orarius* presents a closer approach to the condition of the fossil than any other living species. The possible range of variation in the development of these cusps in *S. shultzi* may overlap the condition in *S. orarius*. The molar trigonids in *S. orarius* are not as compressed as in *S. shultzi* or the other species. The M/1 has a low anterolingual cingular cusp in *S. orarius*.

Scapanus latimanus is only slightly larger than *S. shultzi*. The labial cingula on the molars are much reduced in *S. latimanus* approaching the condition in *Scalopus* and the anterolingual cingular cusp on M/1 is lacking. The lingual cingular cusps approach the degree of development seen in *S. shultzi*. The paraconid on M/1 in *S. latimanus* is reduced over the condition seen in *S. shultzi* and the trigonid is more open lingually. The trigonids of M/2-3 are compressed as in the fossil species. In early wear, a small cuspule (metastylid) between the entoconid and metaconid blocks the lingual opening of the talonid valleys in all the molars of *S. latimanus*. It is possible that the talonids of *S. shultzi* also possess a tiny metastylid in early wear, but at the state of wear of the available specimens this cannot be definitely determined. A suggestion of a metastylid is present in the M/3 of the holotype of *S. shultzi*.

Discussion. — The Clarendonian *Scapanus shultzi* constitutes a reasonable common ancestor for the hypsobrachyodont living species as far as its lower jaw and teeth are concerned. The lower jaw of *Scapanus townsendii* can be derived from it by overall size increase, accompanied by lengthening of the molars, complete fusion of P/4 roots, and slight suppression of the lingual and labial cingular cusps.

Scapanus orarius can be derived from *S. shultzi* with even fewer modifications. Complete fusion of the roots of P/4, and a slight opening of the trigonids would be the morphological changes involved.

The lower jaw of the hypsodont *Scapanus latimanus* requires more modifications in its hypothetical derivation from *S. shultzi*. These changes involve reduction in size of P/4 and complete fusion of its roots, increase in height of crown and suppression of the labial cingula on the molars, and elimination of the anterolingual cingular cusps and reduction of the paraconid on M/1. Perhaps differentiation of the line leading to *S. latimanus* had taken place prior to Clarendonian time. In any case *S. shultzi* may not be far from a common ancestry with *S. latimanus*.

Continuation of the same trends leading to *S. latimanus* could also yield *Scalopus* through an intermediate form such as *Hesperoscalops* Hibbard, 1941. Some additional modifications would be necessary such as an increase in size and hypsodonty and the loss of premolars and possibly incisors. Considering the variability in numbers of antemolar teeth in some scalopines, loss of the anterior dentition may not be too drastic a modification to have taken place during the span of Pliocene and Pleistocene time. Loss of premolars is a common feature of variation within populations of *Scapanus latimanus* in Southern California and Baja California (Palmer, 1937). Loss of a premolar above or below occurs in *S. l. occultus* from Los Angeles County, California, whereas reduction to three premolars above and below seems to be complete in *S. l. anthonyi* from Northern Baja California. Further reduction to two premolars above and three below is occasionally found in *S. l. anthonyi.*

In 1956 Green described a lower jaw of an insectivore, *Domninoides riparensis,* from the late Clarendonian Wolf Creek local fauna of South Dakota. Green placed this form in the Soricidae pointing out its similarity to *Domnina,* an Oligocene soricine. On the basis of Green's description and figure, and closely allied material from the late Barstovian Niobrara River local fauna in the U.C.M.P. collection, I believe *Domninoides* is clearly a talpid. The reasons for this reassignment are outlined in the following comparison:

1. Dental formula. — Said to be I/1, C/0, P/1-4, M/1-3 in *Domninoides* by Green, which would agree with *Domniina* and not with the Talpidae. Green's figures, however, suggest additional alveoli at the front of the jaw. For the present I feel that the evidence for the ante-premolar dental formula is open to question and should not be relied on in assessing the affinities of this form.

2. The nature of "I/1", Green's figure shows an alveolus, apparently identified as "I/1", which indicates a tooth whose root is distinctly smaller relative to jaw size than in the enlarged incisor of *Domnina.* To link the two genera would involve reduction in size of "I/1".[1]

3. PREMOLARS. — *Domninoides* agrees with *Domnina* and *Scapanus* in the possession of four premolars. It differs from *Domnina* in that the lower premolars make a relatively graded series, and the P/2-4 are double-rooted. The second and third lower premolars are not reduced relative to P/1 and P/4 as in *Domnina. Scapanus* has a relatively well graded series from P/1 to P/4, the premolars are not double-rooted, although P/4 is double-rooted in *Scapanus shultzi.* The P/4 in *Domninoides* does not extend forward over the alveolus of P/3 as in *Domnina,* but is upright as in the moles; its form closely approached by *Scapanus shultzi.*

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[1] The single enlarged lower incisor in all known soricids, except the problematical Eocene genus *Saturninia* (three incisors, the middle one enlarged), is usually identified as the I/3 or I/4 following Arnbäch-Christie-Linde (1912).

4. MOLARS. — Like the moles, the molars of *Domninoides* do not decrease in size posteriorly in a regular fashion as in the shrews: M/2, not M/1, is the largest tooth. The talonids and trigonids of the lower molars are compressed anteroposteriorly as in the moles, and not open as in the shrews. The manner of connection of the ridge from hypoconid to metaconid is similar to that of *Scapanus* except that in the latter the low ridge noted between the entoconid and metaconid in *Domninoides* is enlarged so that the talonid basin is encircled. In most shrews the talonid valleys are widely open lingually, the hypoconid connecting the posterolingual base of the protoconid.

Domninoides agrees that *Scapanus* in the characters listed above as common to the Talpidae. It differs from *Scapanus* in larger size; presence of birooted P/1-3; molars with well developed anterior (except on M/1) and labial cingula; M/1-2 with small metastylid with ridge from hypocone connecting this stylid; talonid valleys of M/2-3 open lingually, closed on M/1; anterior mental foramen beneath P/3; and relatively deeper jaw, without marked upward flexure of the ascending portion of the ramus. The presence of a fairly well developed metastylid and the morphology of the talonid recalls *Parascalops* and *Scapanulus.*

The presence of a form generically identical to *Domninoides* in the Niobrara River local fauna is indicated by several lower jaws and isolated teeth associated in the same quarry (Fort Niobrara, U.C.M.P. locality V3218) with a number of limb elements, including humeri, of unmistakable talpid morphology. Evidence of direct association in individual specimens is lacking, but the expected frequency of jaw fragments matches closely that of skeletal elements. No other talpids have been identified among the dental materials from the Fort Niobrara quarry, thus indicating the association of dental and limb material on circumstantial grounds. The description of this material has been undertaken by another worker, but for the time being it suffices to indicate that *Domninoides* seems to represent a distinct line of talpids which can be traced at least from Barstovian to the late Clarendonian time (Green, 1956, p. 153, mentions a possible Arikareean member of this group with reduced anterior cingula on the lower molars). The relationship of *Scapanus* to this group is not clear at present. *Domninoides* seems more closely related to *Parascalops,* in which lingually opening talonid valleys, metastylids and anterior cingula are present on M/2-3.

At present it is impossible with the evidence available to determine the relationships of *Scapanus shultzi* with *Proscalops* Matthew, 1901, *Talpa incerta* Matthew, 1924, or the talpid tooth mentioned by Galbreath from the Martin Canyon local fauna (1953), as none of these forms has been figured or described adequately enough to allow comparison.

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WATER TRANSPARENCY OF THE SOUTHERN CALIFORNIA SHELF[1]

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Introduction

For nearly a century the Secchi disc has been used by limnologists and marine scientists to obtain a rough estimate of transparency. Since the time this simple instrument was described by Ciladi and Secchi (1865), attempts have been made to relate extinction coefficients of visible light, the amount of detrital debris, organism content, and other parameters to Secchi disc measurements. Most of the investigations in recent years have demonstrated that deviations of various magnitudes exist between calculations resulting from disc measurements and other methods of transparency determination (Le Grand 1939, Clark 1941, and Gall 1949). To eliminate the deviations, equipment using light-sensitive selenium cells have been devised, with and without light sources, for both qualitative and quantitative evaluations (Holmes 1957). These advances in instrumentation have lead some to believe that no measurement is valid unless made with a complex device of some kind, even though the electronic characteristics of the photometer or transparency meter may compel one to use it more experimentally than as a matter of routine in oceanographic surveys.

A compilation of several hundred measurements taken over the southern California shelf has pointedly shown the value of the Secchi disc in delineating seasonal and annual variations in transparency and in determining causative agents in relation to other parameters of the water. The significance of such compilations has been shown by Emery (1954) from data obtained over the continental borderland of southern California, and by Stevenson, Tibby, and Gorsline (1956) from information gathered in Santa Monica Bay, California.

More than 800 measurements of water transparency using the Secchi disc have been made in the southern California shelf area since 1953. These were taken by many different individuals, representing a wide range of acquaintanceship with the disc and during as great a variation of light and sea conditions as can be imagined. All measurements were made as a matter of routine with no forethought of future correlation. Considering these factors and the

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[1] Allan Hancock Foundation Contribution 242.

[2] Now at Shell Oil Co., Sacramento, California.

fully recognized inaccuracies involved in utilizing Secchi disc depths, the results that have been obtained are considered truly remarkable.

Acknowledgments

The writers wish to express their appreciation to the Hyperion Engineers, Inc., Los Angeles, to the California State Water Pollution Control Board for the support of oceanographic surveys from which many of the data were obtained, to Dr. Donn S. Gorsline, FSU, for critically reading the manuscript, and to Captain Allan Hancock and the crew of the R/V VELERO IV for their aid while at sea.

FACTORS EFFECTING TRANSPARENCY

Natural effects

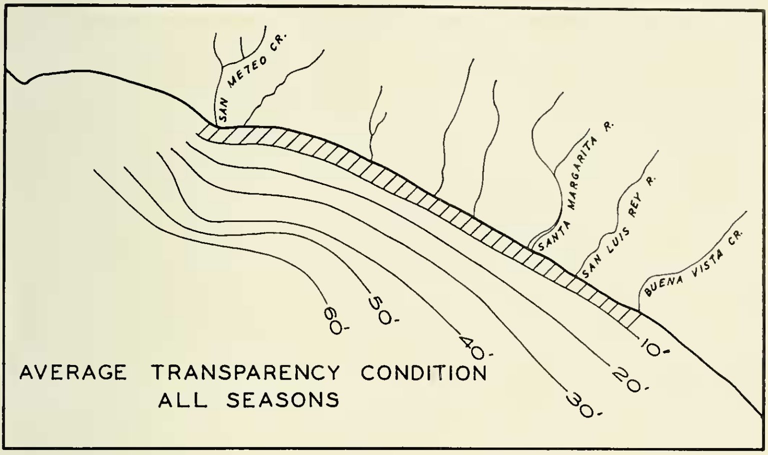
The coast of southern California is in an active stage of erosion and deposition so that detrital material is continually in suspension in the nearshore waters. Approximately 170 miles of the 250 mile coast from Mexico to Point Conception are cliffed. The exposed rocks are mainly poorly indurated shales, silt-stones, and sandstones of Tertiary age, and unconsolidated sands and gravels formed during the Pleistocene Epoch. Isolated headlands and short distances of cliffed shores are composed of various kinds of volcanic and metamorphic rocks. Approximately half of the cliffed coast undergoes erosion from the sea during storms. The remainder is exposed to erosion only during winter and spring rains.

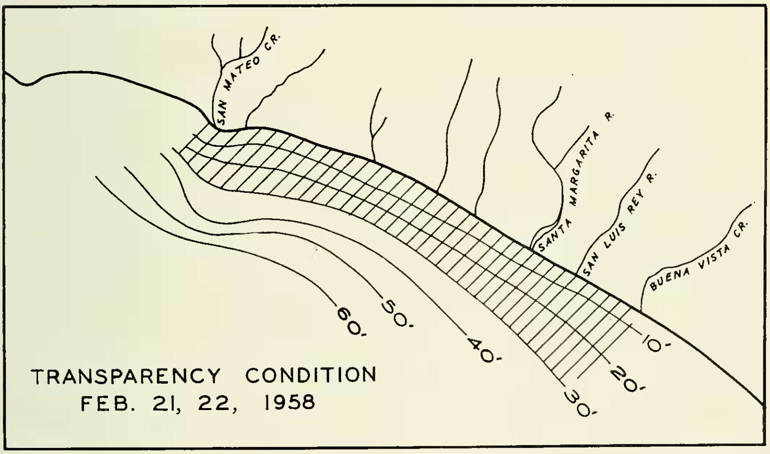
The remaining 80 miles of coastline are bordered by coastal plains, the widest being in the Los Angeles area extending about 25 miles inland, and small triangular deposits at the narrow mouths of intermittent streams that cut through the terraced cliffs adjacent to the shore. The coastal plains are constructional surfaces of alluvial debris deposited by streams. Normally the rivers flow only after rains, but in the past, before man's intervention, some undoubtedly flowed to some extent all year. Wide sand beaches, large and small sandspits, and coastal dunes make up the shores of the plains. The mainland shelf is widest in these areas, eight to fifteen miles in comparison to the one to three miles along the cliffed coast.

The turbidity of the water is greater (transparency less) in waters offshore from the coastal plains than along the cliffed shores. This is a normal condition arising from the more abundant detritus contributed by the rivers, tidal flows from lagoons and estuaries, and by the action of the waves over the shelf in keeping material in suspension for longer periods of time.

Transparencies measured in centimeters rather than in feet, common along the northwest coast of Florida (D. S. Gorsline, and

A





B

PLATE 18

Fig. A. The average transparency of the water over a portion of the southern California mainland shelf near the city of Oceanside, which lies between the Santa Margarita and San Luis Rey rivers.

Fig. B. Transparency of the water over a portion of the southern California mainland shelf near Oceanside on February 21 and 22, 1958 two days following an intense storm in southern California.

P. Hoagland personal communication), are experienced rarely and then under only the most unusual of conditions in a confined area.

The relative effect of river-borne detritus on nearshore transparency can be shown from measurements made near Oceanside, California, on February 21 and 22, 1958, two days following a major storm. There are 12 hydrographic stations in this area, each of which had been occupied 3 or 4 times prior to the February period. The average transparency in all seasons under no-storm conditions is shown in Plate 18, fig. A. The area of readings less than 30 feet has been cross-hatched and indicates a normal condition of a band about one mile wide adjacent to the shore. As the streams flow intermittently there is no detectable effect of their flow on the transparency. Also, from 1956 through 1957 when these measurements were taken, rainfall was so minor that little debris reached the sea from the streams.

In Plate 18, fig. B, the transparency pattern for February 21 and 22 is shown, and again the area where the disc readings of less

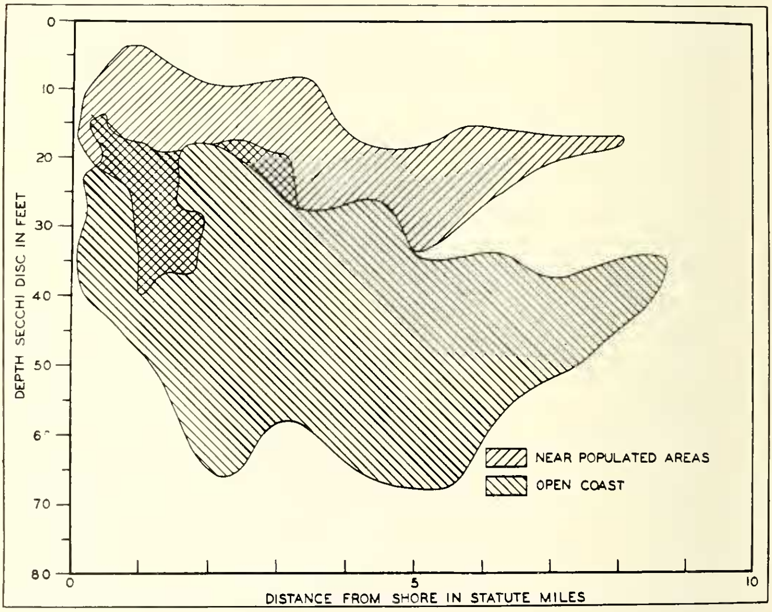


PLATE 19

Depth of Secchi disc readings near populated coasts and along open coasts versus distance from shore. The two distinct areas on the graph show the range of disc readings encountered under all conditions. The upper area shows that transparency near populated shores is normally less than along open coasts regardless of distance from shore.

than 30 feet were obtained is cross-hatched. The band of low transparency has widened to 3 or 4 times its normal width with bulges opposite the major streams San Mateo Creek, Santa Margarita River, and San Luis Rey River. The 50, 60 and 70 foot transparency contours are shifted seaward opposite San Mateo Creek, but are about the same distance from shore along the rest of the coast. The 80 foot depth contour is nearly the same in each instance. Thus, it can be seen that the increased turbidity is impinged upon the normal water with a sharp front bounding the two waters of differing transparency. Likely the edge of the low transparency water became diffused in later days, but it is probable that before much of the detritus spread through more of the shelf water, it settled to the bottom as in the smaller scale phenomenon around sewage outfalls (Stevenson, Tibby and Gorsline, 1956). Dispersal, diffusion and settling obviously depend to a considerable extent upon wind, sea, and swell conditions during the post-storm period.

ARTIFICIAL EFFECTS

The urbanization of man has had an effect on the transparency of coastal waters that is naturally more obvious where the population is greatest (Plate 19). The decrease in transparency is most conspicuous in the Los Angeles region where nearly four million inhabitants are crowded onto the coastal plain.

There are several contributing factors from man's constructive activities, but in only one is the magnitude of the effect known. This is the turbidity resulting from the discharge of sewage effluent into the ocean at Playa del Rey, Whites Point and Newport Beach. During 1955-56 the University of Southern California conducted an intensive oceanographic survey in Santa Monica Bay to determine the desirability of lengthening the submarine outfall pipe and increasing the volume of sewage flow. In the course of the survey many hydrographic stations were occupied in the vicinity of the three outfalls. One of the parameters measured at these stations was water transparency. Measurements were made with both Secchi disc and a transparency meter. From these data it was determined that, except under unusual oceanographic conditions, the effect of sewage discharge on transparency was not measurable beyond a distance of two nautical miles at the City of Los Angeles' Hyperion outfall (Stevenson, Tibby, and Gorsline 1956). Here more than 250 million gallons of effluent are discharged each day. Lower volumes have a decreasing effect, and at the Newport Beach outfall of the County of Orange (25 MGD) the contributed turbidity was not measurable more than a few hundred feet from the discharge site.

The effect of other man-made factors is difficult to evaluate, mainly due to the lack of data. The main artificial contributors to nearshore turbidity are, however, drainage from flood control channels and storm drains, erosion of beaches around groins, jetties, and breakwaters, and the tidal flow of turbid water from harbors. Each is of varying local importance, but all three contribute significantly in the waters off the Los Angeles area.

HYDROPHOTOMETER AND SECCHI DISC MEASUREMENTS

In the winter of 1957-58 at 54 hydrographic stations in various localities on the southern California shelf, Secchi disc readings and light measurements from a hydrophotometer were taken simultaneously. The hydrophotometer used was similar to that described by Holmes (1957) with a deck cell, a submerged cell, and an indicating unit reading in micro-amperes. Others have made similar measurements (Le Grand 1839 and Clarke 1941, for example), but in southern California the stations were in coastal waters and represented a greater variety of water conditions than those encountered in the previous investigations. The percentage of light at the surface remaining at the Secchi disc depth was computed without assuming a 15% light loss at the surface as did Poole and Atkins (1929). Thus, the values are lower than they reported but are valid for the purpose of comparison.

As noted in Plate 20, the percentage of light at the compared depths varied from 3.2% to 22%, but most of the values are so grouped that a best-fit line can be drawn. The interesting feature of the results is that at the shallower depths at which the disc disappeared from sight there was two times or more the percentage of light remaining than at the greater depths. Were this variation irregular in nature one might suspect the readings of either or both instruments, but even though both are prone to some inaccuracies the plot is too regular to dismiss for this reason. The data presented by Poole and Atkins (1929) and Clarke (1941) indicate similar conditions at their stations. Of particular interest is Clarke's station #542 taken off Trinidad where a series of readings gave results reasonably similar to those reported here.

This condition appears to be due to the effect of scattering by particles, with the more turbid the water the greater this effect. As noted by Clarke (1941) and Sauberer (1939) where scattering is greater the light from a Secchi disc would be more diffuse and therefore less easily seen from the surface. Since scattering by particles is relatively high whereas absorption is low in the ocean, and scattering does not greatly effect vertical extinction, the conditions as noted in Plate 20 appear reasonable. From this it is perfectly obvious that the Secchi disc is far from a reliable

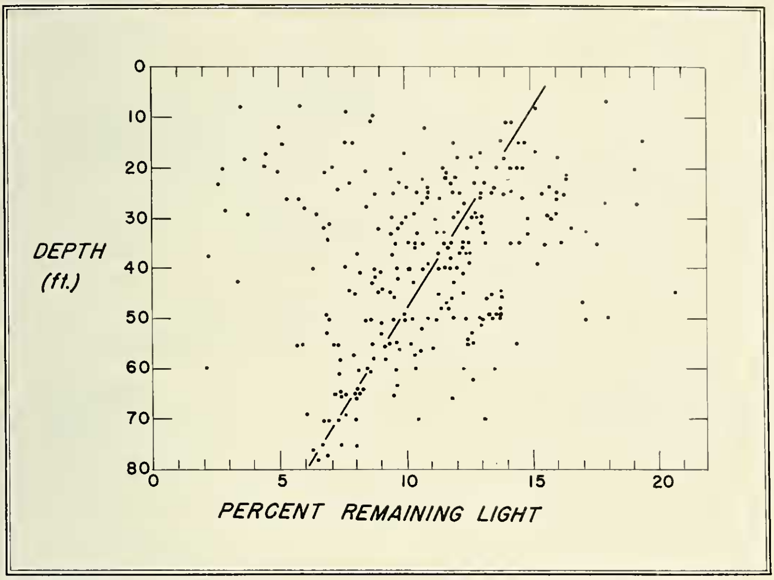


PLATE 20

The per cent of light remaining as determined from a hydrophotometer at the disappearance depth of the Secchi disc.

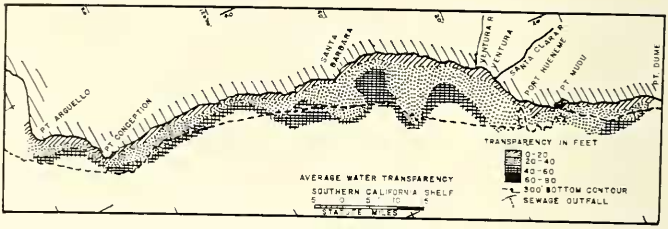
instrument to determine the amount of light present at a given depth. On the other hand it is equally obvious that the photometer used at these stations is not a reliable means of determining the depth to which a person can see into the water. To the engineer, fisherman, and beach visitor the depth at which an object can be seen is more important than extinction coefficients and the like. Conversely, the amount of light present at a given depth is of importance to biologists, ecologists, and others. Thus, one must judge the value of the instrument by the characteristic of the water that is desired rather than by the relative complexity or accuracy.

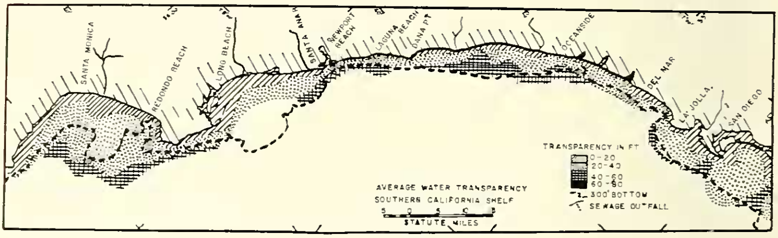
THE WATER TRANSPARENCY

AVERAGE CONDITIONS

Upon a natural background of turbidity from wave erosion and river drainage has been constructed a series of communities with growth rates unparalleled in the United States. These cities and towns extend more or less continuously from Santa Barbara to San Diego, a distance of more than 200 miles. The effects of this tre-

A





B

PLATE 21

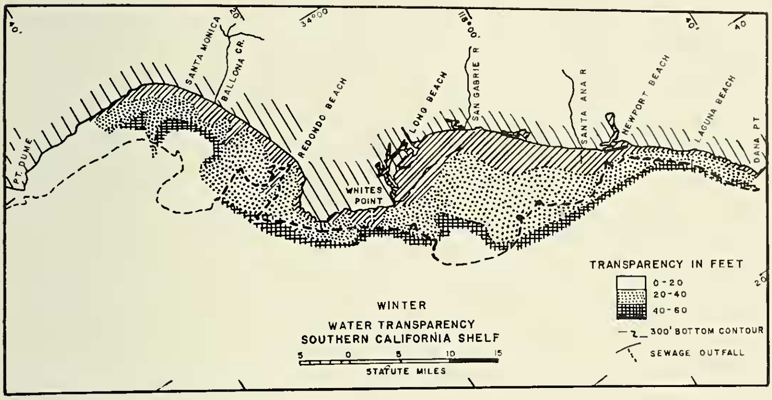
Fig. A. Average transparency of the water over the southern California shelf; Point Conception to Point Dume.

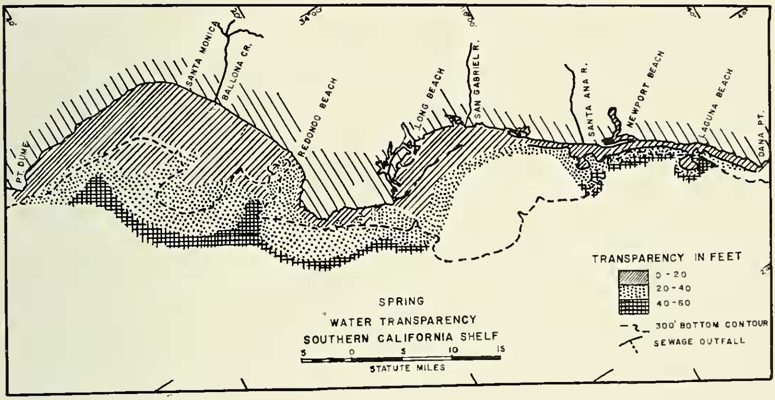
Fig. B. Average transparency of the water over the southern California shelf; Point Dume to the Mexican Border.

mendous population on sea water turbidity is at times marked, as noted previously. But perhaps the most interesting feature is that although the waters with low transparencies extend farther from shore where the concentrations of population occur, these areas are where the shelf widens and the transparency would normally be less in any event (Plate 21, figs. A and B). The total effect of the works of man may then be minor in producing the exceptionally low transparencies often considered the normal consequence of such progress.

The charts showing average transparency (Plate 21) indicate that moderately turbid water (20-40 feet of transparency) is common 12 to 15 miles from shore where populations are concentrated. In most of these areas this water extends well beyond the edge of the mainland shelf, a conditon not occurring along the so-called "open coasts." In the latter areas clear oceanic water intrudes over the shelf, often to within a mile of shore. Even over the Santa Barbara and San Diego shelves, tongues of offshore water project towards shore to a considerable extent. Such does not

A





B

PLATE 22

Fig. A. Average water transparency during the winter of the shelf waters between Point Dume and Dana Point.

Fig. B. Average water transparency during the spring of the shelf waters between Point Dume and Dana Point.

occur over the Santa Monica Shelf, and probably this clearer water is absent at San Pedro.

Man's activities are noticeable, therefore, but have not produced exceptional areas of abnormally low transparencies when average conditions are considered.

Seasonal variations

The winter and spring transparency measurements show most dramatically the effects produced by land drainage and man's construction. During the winters of 1953 to 1956, rain was not plentiful in southern California. When it did fall, the parched soils and the short periods of precipitation reduced the runoff into the ocean. Plankton populations were not great so that in these winters the water was clearer than during years of greater rainfall. The low transparency water occurred in a rather narrow band close to shore (Plate 22, fig. A). Extruding from this band, resulting in seaward projections of turbid water, were the discharges from sewer outfalls and harbors, and detrital material from beach erosion. The large Hyperion outfall produced the turbid projection south of Ballona Creek. The Los Angeles County outfall (150 MGD) formed the low transparency bulge at Whites Point. The area south of Long Beach was turbid due to the flow of tidal waters from the Los Angeles-Long Beach Harbor, and the Orange County outfall at the Santa Ana River mouth probably added a minor amount of detritus in that area.

Beach erosion along the shore of the Los Angeles Basin is most pronounced at Redondo Beach and at the San Gabriel River mouth. The seaward projections in these two areas may be attributed to this erosive activity, although a southerly inshore current in Santa Monica Bay probably brings sewage debris to the Redondo area to increase turbidity there.

The spring seasons of the above noted years had rains and plankton growths that were impressive in contributing lowered transparencies (Plate 22, fig. B). Runoff was most noticebale at the Santa Ana River mouth and Laguna Beach. However, the tremendous area of transparency less than 20 feet in Santa Monica Bay was also due to runoff, in this case from Ballona Creek and a number of streams from the Santa Monica Mountains on the north side of the bay. This detritus, plus blooms of blue-green algae and phytoplankton, resulted in the low transparencies in this area in the spring.

Little detritus is contributed to the water off Whites Point during rains, so that even during the spring, the effect of the outfall is considerable. In Santa Monica Bay, however, the turbid effluent is lost in the much greater contribution from other sources.

Resume

The average transparency of the water over the mainland shelf of southern California is influenced by oceanographic, geographic, climatologic and geologic factors that differ in most respects from those of other coastal areas in the United States. The transparency is much greater than along the Gulf Coast and less than along the New England coast.

The most important factors are the physiographic and geologic nature of the coast and shelf. Great quantities of fine-grained detrital material are available to be transported to the sea from a coast with a rather high relief. When the rivers and streams flow, the effect is obvious. With a narrow shelf, deep water close to shore, and consequently minor wave action over a large area, a more or less quiescent sea exists so that the detritus settles quickly. Low transparencies are thus generally close to shore and the clear oceanic water is not far distant.

Seasonal differences due to variations in rainfall, algal blooms and wave activity are present and result in marked changes in transparency patterns. Winter is the usual season when transparencies are greatest; spring when they are the least.

The effects caused by population growth and the accompanying constructive activities of man are apparent, but only by degree rather than magnitude. Their impressions on the average condition are negligible and are best noted in restricted areas.

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THE DISTRIBUTION OF THE SINALOA NARROW-MOUTHED TOAD, *Gastrophryne mazatlanensis* (Taylor)

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As a result of recent collections of the Sinaloa narrow-mouthed toad, *Gastrophryne mazatlanensis* (Taylor), outside its supposed range, it seems advisable to briefly review the distribution of this poorly known amphibian. Charles F. Walker of the University of Michigan Museum of Zoology and Richard G. Zweifel of the American Museum of Natural History have assisted me in locating museum specimens. William H. Woodin, III of the Arizona-Sonora Desert Museum has kindly allowed me to report on important specimens collected by him.

On August 2, 1959, collections of amphibians were made by Roy W. McDiarmid, Jr., and me along state highways 85 and 86 between Ajo, Lukeville, and Tucson, Pima County, Arizona. In the late afternoon a heavy downpour of rain occurred causing numerous flash floods. The ditches as well as the floor of the desert were covered with water that flowed across the road in almost every dip, often forcing traffic to halt temporarily. Anurans were present in large breeding choruses. At about 9:00 p.m., six adult *Gastrophryne mazatlanensis* were collected on highway 86 near a drainage in the San Simon Valley at a point approximately 28 miles east-southeast of Ajo. The specimens range from 25 to 33.2 mm. in snout-vent length and agree in coloration with the type of *G. mazatlanensis* as described by Taylor (1943). The venter is cream colored with a slight peppering of pigment on the chin and somewhat more pigment along the sides. A distinct black bar extends across the tibia and femur of the folded limb in five specimens and is faintly indicated in the sixth. Other amphibians in the area included *Bufo cognatus, Bufo alvarius, Bufo retiformis, Scaphiopus hammondi,* and *Scaphiopus couchi.* In the late afternoon of August 2, individuals of *Gastrophryne* were heard calling about three miles southeast of Ajo in a large chorus of *Scaphiopus couchi* immediately following a heavy downpour of rain. Search for these individuals was fruitless.

William H. Woodin, III has recently informed me of specimens of *Gastrophryne* collected by him and Mervin W. Larson in the middle of the San Simon Valley at a point approximately

37 miles east-southeast of Ajo on July 29, 1958. *Pternohyla* was collected at the same locality.

Both of the above localities represent northwestern extensions of the known range of *Gastrophryne mazatlanensis.* The first reported locality is about 85 miles northwest of the previous northwestern record (1.3 miles northwest of Ruby, Santa Cruz County, Arizona; Williams and Chrapliwy, 1959), and represents the northern and western records for the species. The species doubtless occurs to the north and west of the new localities, as is evidenced by the call record reported above. The localities reported upon in this paper are located on the floor of the San Simon Valley in areas of typical Sonoran Desert floral associations. San Simon Valley is separated from the other localities at which *Gastrophryne* has been collected in Arizona by the Baboquivari and Quijotoa Mountain ranges and by the broad Altar Valley.

The Sinaloa narrow-mouthed toad was described by Taylor (1943) as *Microhyla mazatlanensis.* A single specimen of *mazatlanensis* (UMMZ 78333) from ten miles north of Pilares in northeastern Sonora was considered to be somewhat intermediate between *mazatlanensis* and *olivacea* by Hecht and Matalas (1946), but this specimen is not said to be a member of an intergrading population and is not indicated as an intergrade on the accompanying map. However, Hecht and Matalas regarded both *olivacea* and *mazatlanensis* as subspecies of the polytypic *Microhyla carolinensis.* Recently, Blair (1955 a, 1955 b) has presented evidence to show that *carolinensis* and *olivacea* are separate species, and *mazatlanensis* has been assigned by him as a subspecies of *olivacea.* Hybridization, not intergradation, apparently occurs in regions where the ranges of *olivacea* and *carolinensis* overlap. Blair (1955b) has shown that the call of *mazatlanensis* is more similar to that of *carolinensis* than to that of *olivacea.* The arguments presented by Hecht and Matalas (1946) concerning the taxonomic position of *mazatlanensis* remain unconvincing, and, in view of the recent discoveries concerning *carolinensis-olivacea* relationships, as well as the fact that *olivacea* and *mazatlanensis* are allopatric and distinct with little or no evidence of intergradation, it seems advisable to consider *mazatlanensis* a separate species. Search should be made in western Chihuahua and western Durago for sympatric populations or evidence of intergradation.

Carvahlo (1954) has demonstrated that the narrow-mouth toads of the *carolinensis-olivacea-mazatlanensis* complex are not congeneric with Old World *Microhyla* and referred them to the genus *Gastrophryne.*

The accompanying map illustrates the distribution of *G. mazatlanensis* as indicated by museum specimens or literature reports. A list of localities at which *G. mazatlanensis* has been collected is presented below. Abbreviations are as follows: AMNH, American Museum of Natural History, UMMZ, University of Michigan Museum of Zoology.

MEXICO

Sinaloa:

2 miles E Mazatlan, (Taylor, 1943), TYPE
18.6 miles NNW Mazatlan, UMMZ 115461

Sonora:

Guirocoba, (Bogert and Oliver, 1945)
Alamos, (Bogert, 1958)
3 miles NW Navajoa, UMMZ 117354
Hermosillo, AMNH 63736
22.5 miles W Hermosillo, (Zweifel, in litt.)
5 miles N Noria, (Allen, 1933)
Trincheras, AMNH 53029-32
10 miles N Pilares (Hecht and Matalas, 1946)
35.5 miles S. Nogales, (Langebartel and Smith, 1954)

UNITED STATES

Arizona:

Santa Cruz County:

Peña Blanca Springs, (Campbell, 1934; Stebbins, 1951; Blair, 1955 b)
Near Yank's Spring, Sycamore Canyon, (Stebbins, 1951)
Vicinity of Patagonia, (Stebbins, 1954)
1.3 miles NW Ruby, (Williams and Chrapliwy, 1959)

Pima County:

37 miles ESE Ajo, (Woodin, in litt.)
28 miles ESE Ajo

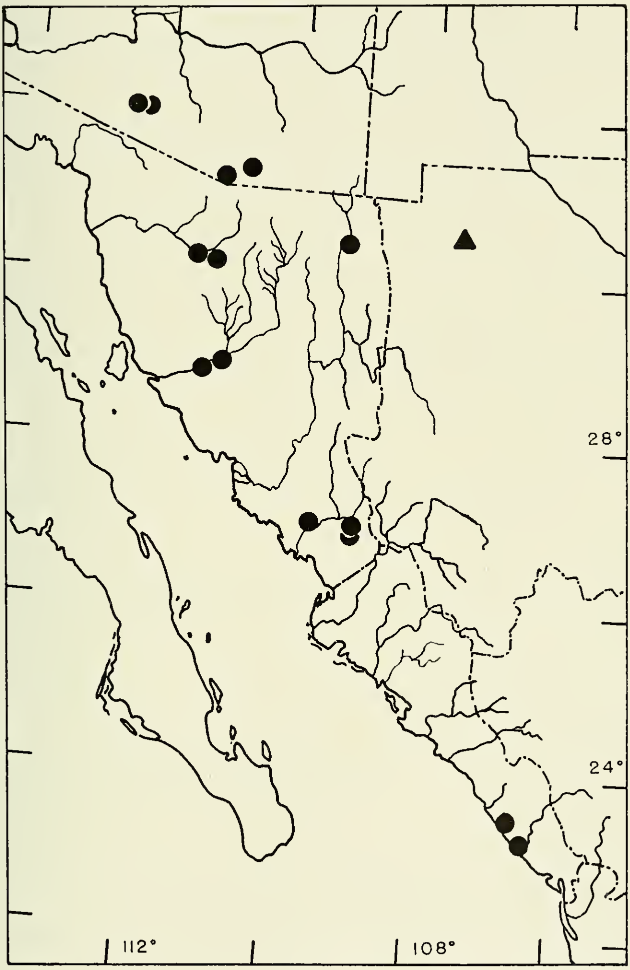

PLATE 23

MAP LEGEND

Distribution of *Gastrophryne mazatlanensis* in Northwestern Mexico and Southwestern United States. Collection localities indicated by circles. Nearest record of *Gastrophryne olivacea* indicated by triangle.

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THE EGGS OF TOADS OF THE *BUFO BOREAS* GROUP, WITH DESCRIPTIONS OF THE EGGS OF *BUFO EXSUL* AND *BUFO NELSONI*

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As part of a program of biosystematic analysis of variation and evolution in North American toads of the *Bufo boreas* Group we have assembled materials for comparative life history studies. Among the collections are samples of the eggs of the isolated dwarf desert forms *Bufo exsul* Myers, from Deep Springs Valley, Inyo County, California and *Bufo nelsoni* Stejneger, from the Amargosa River, Nye County, Nevada. Since no detailed account of the eggs of *B. nelsoni* has been published previously, a description and figure (Plate 24) are presented, together with comparative notes on the eggs of the related forms *Bufo boreas* Baird and Girard and *Bufo canorus* camp. In addition we find that the recent description of the eggs of *B. exsul* (Livezey, 1960) is incomplete or erroneous and the eggs of this form are redescribed on the basis of more adequate material. *Bufo alvarius* Girard has also been placed in the *B. boreas* Group by some authors (Blair, 1959) and eggs of this species are included in the comparisons (Plate 24).

Bufo nelsoni have been taken during the breeding season on only one occasion. Several hundred examples were observed in amplexus on March 19, 1960, by A. J. Gaudin and J. M. Savage. All breeding pairs were in shallow waters along the edge of the Amargosa River, two miles south of Springdale, Nye County, Nevada. A number of egg masses were collected from shallow water among submerged sedges and many additional strings were counted. All eggs were apparently in masses deposited within the previous 48 hours. Although several hundred mated pairs were noted only a single non-amplexed individual was seen. No toads were found after sunset and it seems likely that *B. nelsoni* is a diurnal breeder. F. W. Schuierer visited the same area on April 1 and 2, 1960, but no breeding pairs were seen. About 50 specimens were collected after sunset and a number of tadpoles and a single egg mass were found. Air temperature at 7:30 P.M. on the first of April was 15° C. Air temperature on the second of April at 11:30 A.M. was 20° C. The water temperature on the first was 15° and on the second 19° C. Eggs produced by artificially stimulated laboratory females of *B. nelsoni* agree in all important details with those collected in the field.

In addition to the toads discussed above we have collected adult *nelsoni* along the Amargosa River between Springdale and Beatty, Nye County, Nevada, on the following dates: March 30, May 17, June 20 and November 9, 1958 and June 13, 1959. Linsdale (1940) mentions larvae seen on May 4, 1932 and Wright and Wright (1949) record larvae taken on May 13, 1942. Mature larvae were collected by F. W. Schuierer as part of the present study on May 17, 1958. These data indicate that breeding probably begins in mid-March and continues over a two week period into early April. We have taken recently metamorphosed toadlets in June of 1958 and 1959. Apparently *B. nelsoni* first emerges from hibernation in March and is active during the day. After the breeding season the toads become increasingly nocturnal as diurnal temperatures rise. By mid-April little or no activity is observed in the daytime but the toads are numerous and found feeding at night.

The eggs of *Bufo exsul* have been collected by us on three occasions from amplexed females taken in the slough area at the base of Buckhorn Springs, six miles southwest of Deep Springs Post Office, Inyo County, California. In the first instance eggs were obtained by Richard Clark and F. W. Schuierer on March 30, 1958. The eggs were deposited in long strings and were loosely attached to sedge plants in a water depth of 16-20 cm. The source of the water is an underground stream system and water temperatures remain relatively constant at 20-21° C. during the entire year. Air temperature at noon on the day of collection was 10° C. A considerable number of amplexing pairs of *B. exsul* were taken at the same time and many pairs were seen engaged in breeding activity. Two undispersed clusters of free larvae were also noted and seem to indicate that breeding commenced some few days earlier. Breeding pairs and eggs were again obtained on March 19, 1960, by Anthony J. Gaudin and J. M. Savage, under conditions similar to those noted in 1958. The eggs were in shallow water, 16-25 cm. in depth, and had all been laid in the previous 48 hours. Air temperature at noon on the day of collection was 21° C. The water temperature in moving streamlets was 21° C. Air temperatures were slightly below 0° C. the previous night. A third collection was made on April 1, 1960 by F. W. Schuierer and party. Only one amplexing pair was observed although over sixty individuals were seen. The number is in marked contrast to conditions on March 19 when over 100 mated pairs were counted. The air temperature was 19.5° C at noon; water temperature 20.5° C. Livezey (1960) reported eggs taken on March 22, 1959, under conditions similar to those described above. He includes no data on breeding activity.

Breeding apparently occurs in this species in late March and early April under the influence of local annual weather differences. Our 1960 collections suggest a short breeding season of two to three weeks. All breeding activity observed by us took place during the day. *Bufo exsul* is essentially diurnal at all seasons and breeds at a time of year when nocturnal activity may be lethal. The diurnal breeding habits are in contrast to those of the nocturnal breeding *Bufo boreas.* Larvae *of B. exsul* are numerous in the slough areas below Buckhorn Springs by mid-April and recently transformed individuals are most common in June. Comparison of 10 samples of eggs taken at Deep Springs with eggs produced by laboratory females induced to ovulate by pituitary implants, reveals no marked differences.

The eggs of both *Bufo exsul* and *Bufo nelsoni* share the following features with *Bufo alvarius, Bufo boreas* and *Bufo canorus* (all terms follow the system recommended by Karlstrom and Livezey, 1955) : aquatic deposition in long submerged strings encased in a continuous gelatinous envelope and eggs pigmented. *B. exsul* and *B. nelsoni* further agree with *B. boreas* and *B. canorus* in having two gelatinous envelopes with each egg separated from adjacent eggs by partitions formed from the inner envelope. *B. alvarius* lacks a second gelatinous envelope and has no partitions separating the individual eggs.

Descriptions: *Bufo exsul* — eggs laid in single or usually double strings; usually a single row of eggs in string but sometimes two rows; two jelly envelopes, outer envelope large, 4.0-6.9 mm. in diameter, with even margins and no evidence of scalloping; inner envelope surrounds each ovum and usually in contact with inner envelopes of next adjacent eggs so as to form a series of partitions, greatest diameter 2.4-3.3 mm., least diameter 2.0-2.8 mm.; ova dark in color, brownish black to jet black, vegetal pole lighter, diameter 1.2-1.4 mm., approximately 60 ova in a single file 10 cm. in length.

Bufo nelsoni — eggs laid in single or usually double strings; only a single row of eggs in string; two jelly envelopes, outer envolope large, 4.3-5.0 mm. in diameter, with even margins and no evidence of scalloping; inner envelope encasing each ovum and usually in contact with inner envelopes around next adjacent eggs to form partitions, greatest diameter 2.1-2.7 mm., least diameter 1.4-2.2 mm.; ova dark, blackish above, somewhat lighter at vegetal pole, diameter 1.3-1.8 mm., approximately 60 ova in a single file 10 cm. in length.

Comparisons: A summary of salient characteristics for the five specias, *alvarius, boreas, canorus, exsul* and *nelsoni,* is presented below (Table 1) and illustrated (Plate 24). Eggs may be in

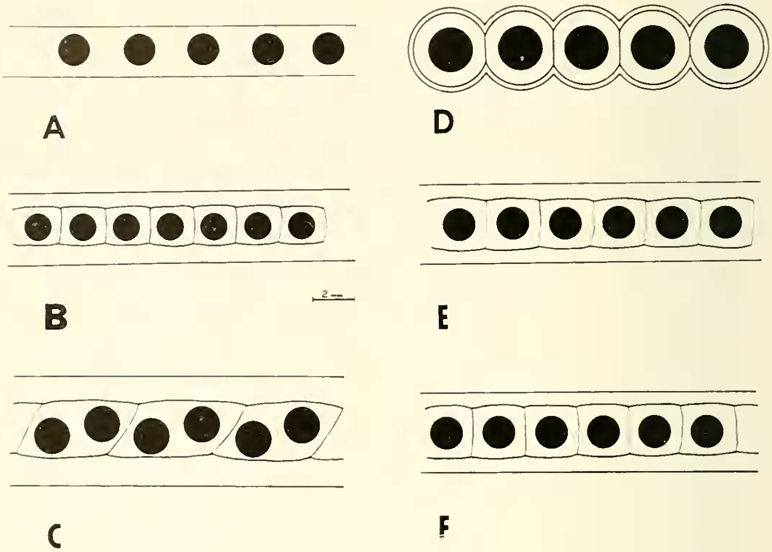

PLATE 24

Diagrammatic Representations of Eggs of Members of *Bufo boreas* Group. A. *Bufo alvarius;* B., C. *Bufo boreas;* D. *Bufo canorus;* E. *Bufo exsul;* F. *Bufo nelsoni.* All eggs drawn to same scale.

single or double rows in *B. boreas, B. canorus* and *B. exsul* but are usually single in the latter two species and always single as far as known in *B. alvarius* and *B. canorus.* Double rows are typical of *B. boreas. B. canorus* is unique in the group in frequently having the eggs deposited to form a radiating network or clusters of four to five eggs in depth and in the scalloped outline of the outer gelatinous envelope. *B. alvarius* differs from the other species and figures of *Bufo canorus* eggs are based on the

The data and figures of *Bufo canorus* eggs are based on the account by Karlstrom and Livezey (1955) and eggs deposited by laboratory females stimulated to ovulate with pituitary implants. Eggs deposited in the laboratory agree in all essentials with the description by Karlstrom and Livezey. The data and figure of the eggs of *B. alvarius* are taken from the synopsis by Livezey and Wright (1947).

In previous descriptions of the eggs of *Bufo boreas* no mention has been made of the partitions formed by the inner gelatinous membrane between individual eggs (Storer, 1925: 178; Livezey and Wright, 1947: 195; Stebbins, 1951: 241; Karlstrom and

Table 1

EGGS OF TOADS OF *BUFO BOREAS* GROUP

	Outer Envelope	Diameter of Outer Envelope		Diameter of Inner Envelope		Diameter of Ovum	Eggs per 10 cm.
		Maximum	Minimum	Maximum	Minimum		
B. alvarius	even	2.1-2.3 2.2	same	none	none	1.1-1.7 1.4	48-112
B. boreas	even	3.1-4.0 3.6	same	2.2-3.1 2.7	1.9-2.5 2.2	1.2-1.5 1.3	120 (two rows)
B. exsul	even	4.0-6.9 5.8	same	2.4-3.3 3.0	2.0-2.8 2.4	1.2-1.4 1.3	60
B. nelsoni	even	4.3-5.0 4.7	same	2.1-2.7 2.4	1.4-2.2 1.8	1.3-1.8 1.5	60
B. canorus	scalloped	3.7-4.6 4.1	0.5-3.9 2.6		3.4-4.1 3.8	1.7-2.7 2.1	28

Livezey, 1955: 222). Our material from several southern California localities all exhibits the partitions as indicated (Plate 24). The inner membranes have the same segmental relations in all *boreas* eggs examined although there is some variation in the number of eggs, one or two, inclosed in each partitioned segment. The inner membranes and partitions are clearly evident only if substage lighting is used in examining the eggs. The partitions are especially difficult to locate even with proper lighting when the outer gelatinous envelope is dirty. Very likely the inter-egg partitions have been overlooked by previous workers although it is possible that the partitions are variable in *Bufo boreas.* Very few *B. boreas* egg masses have been described in the literature and it seems that all of the references to egg size and structure in this species are based upon repetition of the data provided by Storer (1925) and Livezey and Wright (1947).

In basic characteristics the eggs of *B. boreas, B. exsul* and *B. nelsoni* are similar. The principal point of difference is in the tendency for *boreas* to deposit eggs in a dual series within each string, while the other species usually have a single row. Although there appears to be some slight difference among the species in the diameter of the outer jelly membrane, the variation is probably more apparent than real. The jelly coats usually imbibe water when the eggs are laid and considerable differences may be produced by local conditions, time of preservation and strength of preservative. Storer (1925: 178) gives outer envelope diameters for *boreas* as 4.9-5.3 mm. and maximum inner envelope diameters as 3.5-3.8 mm. His values are somewhat higher than those recorded in the present study (Table 1). The size of the ovum appears to be greater in *B. nelsoni* than in either *boreas* or *exsul.* Storer's (1925) values and those of Livezey and Wright (1947) for *B. boreas* are again greater than those recorded in this study, 1.6-1.7 mm. and 1.5-1.8 mm., respectively. The sizes recorded by these authors include the limits of variation noted for *B. nelsoni* eggs (Table 1.).

Livezey (1960) in his description of the eggs of *Bufo exsul* presents measurements for a single egg mass as follows: diameter of outer envelope 4.5-6.6 mm.; diameter of inner envelope (maximum) 2.7-3.8 mm.; diameter of vitellus (late blastula) 1.5-1.8 mm. The last two values are much higher than ours (Table 1) but the differences are probably due to the age of the eggs. Our measurements are based on recently deposited eggs, either unfertilized or at early cleavage. The eggs were preserved after soaking in water for two to five hours after deposition. The description given by Livezey differs from that given above in one additional significant point. He mentions and figures the eggs of the Deep Springs toad as either in a continuous string or with partial partitions between them. Although partitions occur between the eggs in all of our *exsul* strings, a few short segments in most strands lack visible divisions. Reduction in the partitions begins to occur as the vitellus grows and develops. We suggest that Livezey's material is not typical of freshly laid eggs but represents a condition resulting from the relatively advanced stage of development in his embryos.

The eggs of *Bufo canorus* differ strikingly from those of the three species discussed above in the scalloped outer envelope, size of the ovum and diameter of the inner envelope. The number of eggs per 10 cm. of string length (28) reflects the latter two characteristics. Very little is known concerning the ecologic significance of the features which differentiate amphibian eggs but it appears likely that the high altitude habitat (above 9,500 feet in the Sierra Nevada of California) of *B. canorus* is related to its peculiar eggs. The period of development in this species is abbreviated and the daily temperature fluctuations in the shallow breeding ponds are extreme. Larger eggs and jelly envelopes as well as the tendency for clustering of the eggs may be related to temperature adaptations in the development of *Bufo canorus.*

The eggs of *Bufo alvarius* differ strikingly from other members of this group in completely lacking an inner gelatinous membrane and partitions between individual eggs. The eggs and single gelatinous envelope are much smaller than in the other toads discussed in this report. If *B. alvarius* is actually a member of the *Bufo boreas* Group as proposed by Blair (1960) it is as different from other members of the stock in egg characteristics as in morphological features (Plate 24).

Materials used in the present report was obtained with the financial support of grants from the Penrose Fund of the American Philosophical Society and the National Science Foundation. Illustrations were prepared by Priscilla H. Starrett of the University of Southern California.

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RECORDS OF FLEAS (SIPHONAPTERA) FROM NORTHWESTERN ARIZONA

By G. F. Augustson and Floyd E. Durham

The "Strip Area" of northwestern Arizona has been visited many times since 1956 by the junior author. Besides a wealth of native mammals, and many notes on their ecology, a large collection of ectoparasites were obtained. Among the latter are many specimens of fleas which are considered worthy of recording and placing in the collections of the Hancock Foundation. There follows a phylogenetic list of these with the number and sex of each.

A list of the collecting stations has been compiled. It is accompanied by a map (Plate 25) of the area, all in Mohave County. Numbers in parentheses in the text refer to these stations.

Host animals were identified by the junior author and Dr. Donald F. Hoffmeister, Museum of Natural History, University of Illinois, Urbana, where the study skins have been retained. Flea identifications are those of the senior author, who is grateful for the opportunity of studying such an interesting and large series.

Collecting Stations

1. Beaver Dam, 1900 feet.
2. 12 mi. S., 1 mi. W. Littlefield, 5000 ft.
3. 13 mi. S., 4 mi. W. Littlefiield, 3200 ft.
4. 17 mi. N., 3 mi. E. Pakoon Springs, 4250 ft.
5. 13 mi. N., 1 mi. E. Pakoon Springs, 4000 ft.
6. 9 mi. N., 5 mi. W. Pakoon Springs, 4500 ft.
7. 7 mi. N., 5 mi. W. Pakoon Springs, 4500 ft.
8. 3 mi. N., 1 mi. W. Pakoon Springs, 2800 ft.
9. Pakoon Springs, 2300 ft.
10. 2 mi. S., 3 mi. E. Pakoon Springs, 2100 ft.
11. 3 mi. S., 3 mi. W. Pakoon Springs, 2200 ft.
12. 4 mi. S. Pakoon Springs, 1900 ft.
13. 6 mi. S., 1 mi. W. Pakoon Springs, 2000 ft.
14. 8 mi. S., 1 mi. W. Pakoon Springs, 1600 ft.
15. Grand Wash, 1200 ft.
16. Tasi Springs, 1840 ft.
17. 3 mi. S., 8 mi. E. Pakoon Springs, 2900 ft.
18. 4 mi. S., 10 mi. E. Pakoon Springs, 4200 ft.
19. 8 mi. S., 9 mi. S. Pakoon Springs, 4500 ft.
20. 8 mi. S., 12 mi. E. Pakoon Springs, 4400 ft.
21. 8 mi. S., 15 mi. E. Pakoon Springs, 6000 ft.

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[1] Manager-Entomologist, Madera County Mosquito Abatement District, Madera, California.

[2] Allan Hancock Foundation, University of Southern California, Los Angeles, California.

22. 10 mi. S. St. George (Utah).
23. 12 mi. N., 3 mi. W. Wolf Hole, 3500 ft.
24. Seegmiller Mt., 4500 ft.
25. 14 mi. N., 4 mi. W. Mt. Dellenbaugh, 5100 ft.
26. 9 mi. N., 1 mi. W., Mt. Dellenbaugh, 5300 ft.
27. 3 mi. N., 2 mi. W. Mt. Dellenbaugh, 5900 ft.
28. 4 mi. E., 1 mi. S. Mt. Dellenbaugh, 6000 ft.
29. 1½ mi. N.E. Diamond Butte, 4500 ft.
30. 2 mi. S.W. Diamond Butte, 4700 ft.
31. 1 mi. E. of Mt. Trumbull, 5000 ft.
32. 3 mi. N.E. Trumbull Mtn., 6000 ft.
33. Short Creek, 5040 ft.
34. Cutler Pockets, 5500 ft.

FAMILY HYSTRICHOPSYLLIDAE

Atyphloceras echis (Jordan and Rothschild)

1 ♀, 1 ♂ (4) ex *Peromyscus eremicus eremicus* (Baird)
1 ♀ (22) ex *Peromyscus boylii utahensis* Durrant
1 ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

Catallagia chambrelini Hubbard

1 ♀ (7), 1 ♂ (36) ex *Reithrodontomys megalotis megalotis* (Baird)
2 ♀ ♀ (6), 1 ♂ (3) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1 ♀ (25) ex *Peromyscus truei truei* (Shufeldt)

Epitedia stanfordi Traub

4 ♀ ♀ (22) ex *Peromyscus boylii utahensis* Durrant
1 ♀ (3) ex *Peromyscus truei truei* (Shufeldt)

Rhadinopsylla multidenticulatus Morlan and Prince

5 ♀ ♀, 1 ♂ (3) ex *Citellus leucurus leucurus* (Merriam)
5 ♀ ♀, 3 ♂ ♂ (9) ex *Thomomys bottae nicholi* Goldman
1 ♀ (9) ex *Onychomys leucogaster melanophrys* Merriam

Carteretta carteri clavata Good

2 ♀ ♀ (10) ex *Perognathus formosus mohavansis* Huey
1 ♀ (13) ex *Perognathus pencillatus sobrinus* (Goldman)

Meringes dipodomys Kohls

3 ♀ ♀ (11), 1 ♀, 1 ♂ (10), 1 ♀ (12), 9 ♀ ♀ 4 ♂ ♂ (13) ex *Dipodomys deserti* Stephens
1 ♀ (13), 2 ♀ ♀ 1 ♂ (14), 6 ♀ ♀ 12 ♂ ♂ (1), 7 ♀ ♀ 3 ♂ ♂ (15), 5 ♀ ♀ 1 ♂ (16), 5 ♀ ♀ 1 ♂ (11), 8 ♀ ♀ 6 ♂ ♂ (10), 3 ♀ ♀ (17), 2 ♀ ♀ (27) ex *Dipodomys merriami merriami* Mearns
4 ♀ ♀ 2 ♂ ♂ (16), 1 ♀ (14) ex *Onychomys torridus longicaudus* Merriam
2 ♀ ♀ 2 ♂ ♂ (14), 2 ♀ ♀, 1 ♂ (16) ex *Peromyscus crinitus stephensi* Mearns
3 ♀ ♀ (15), 1 ♂ (11) ex *Peromyscus eremicus eremicus* (Baird)
2 ♀ ♀ 1 ♂ (15), 1 ♀, 1 ♂ (11) ex *Neotoma lepida monstrabilis* Goldman

Meringes parkeri (Jordan)

1 ♂ (22) ex *Peromyscus boylii utahensis* Durrant

Anomiopsylla amphibolus Wagner

1 ♀, 2 ♂ ♂ (5), 1 ♀ (28), 1 ♀ (18) ex *Neotoma lepida monstrabilis* Goldman

Jordanopsylla allredi Traub and Tipton

1 ♀ (23) ex *Peromyscus eremicus eremicus* (Baird)

Megarthroglossus becki Tipton and Allred

1 ♂ (6), 1 ♂ (5) ex *Peromyscus maniculatus soroniensis* (LeConte)
2 ♀ ♀ (22) ex *Peromyscus boylii utahensis* Durrant
1 ♀ (5), 5 ♀ ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

FAMILY CERATOPHYLLIDAE

Amphipsylla neotomae Fox

1 ♀ (1) ex *Peromyscus crinitus stephensi* Mearns
1 ♂ (15) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus eremicus (Baker)

4 ♀ ♀ 2 ♂ ♂ (23), 1 ♀ (2), 12 ♀ ♀ 11 ♂ ♂ (15)ex *Peromyscus eremicus eremicus* (Baird)
1 ♀ (5) ex *Peromyscus truei truei* (Shufeldt)

Malaraeus sinomus (Jordan)

1 ♂ (11), 1 ♂ (19) ex *Dipodomys merriami merriami* Mearns
4 ♀ ♀ 4 ♂ ♂ (11), 4 ♀ ♀ 3 ♂ ♂ (12), 11 ♀ ♀ 7 ♂ ♂ (17), 5 ♀ ♀ 5 ♂ ♂-(26), 1 ♂ (31), 1 ♀ (24), 1 ♀ (1) ex *Peromyscus crinitus stephensi* Mearns
9 ♀ ♀ 3 ♂ ♂ (2), 10 ♀ ♀ 5 ♂ ♂ (4), 1 ♀ (13), 1 ♀ 1 ♂ (1), 2 ♀ ♀ 1 ♂ (16), 32 ♀ ♀ 17 ♂ ♂ (11), 20 ♀ ♀ (12), 3 ♀ ♀ (17), 2 ♀ ♀ 1 ♂ (24), 6 ♀ ♀ 4 ♂ ♂-(26) ex *Peromyscus eremicus eremicus* (Baird)
1 ♀ 4 ♂ ♂ (22), 2 ♀ ♀ (1), 4 ♀ ♀ 4 ♂ ♂ (26), 7 ♀ ♀ 1 ♂ (31), 1 ♂ (24) 2 ♀ ♀-2 ♂ ♂ ex *Peromyscus boylii utahensis* Durrant
3 ♀ ♀ (26), 1 ♂ (33) ex *Peromyscus maniculatus sonoriensis* (LeConte)
3 ♀ ♀ (20), 2 ♀ ♀ 1 ♂ (22), 5 ♀ ♀ (8), 1 ♀ (18), 11 ♀ ♀ 2 ♂ ♂ (3), 1 ♀ (26), 1 ♀ 2 ♂ ♂ (28) ex *Peromyscus truei truei* (Shufeldt)
1 ♀ 1 ♂ (11), 1 ♂ (26), 1 ♂ (28), 1 ♀ (3), 1 ♂ (24) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus euphorbi (Rothschild)

1 ♀ (13) ex *Dipodomys merriami merriami* Mearns
3 ♀ ♀ (2) ex *Peromyscus eremicus eremicus* (Baird)
1 ♂ (7) ex *Peromyscus maniculatus sonoriensis* (LeConte)
2 ♀ ♀ (2), 2 ♀ ♀ (7) ex *Neotoma lepida monstrabilis* Goldman

Malaraeus n. sp.

1 ♀ 1 ♂ (1), 1 ♂ (12), 5 ♀ ♀ 3 ♂ ♂ (17) ex *Peromyscus crinitus stephensi* Mearns
1 ♂ (11), 1 ♀ 1 ♂ (16), 4 ♀ ♀ 1 ♂ (17), 1 ♂, 2 ♀ ♀ (12) ex *Peromyscus eremicus eremicus* (Baird)
(Note: in manuscript by Frank M. Prince).

Malaraeus vonfintalis Prince

1 ♀ (7) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1 ♂ (3) ex *Peromyscus truei truei* (Shufeldt)

Monopsyllus eumolpi (Rothschild)

2 ♀ ♀ 2 ♂ ♂ (8),3 ♀ ♀ (25), 1 ♀ (26) ex *Eutamias dorsalis utahensis* Merriam

Monopsyllus exilis (Jordan)

4 ♀ ♀ 2 ♂ ♂ (9), 3 ♀ ♀ 5 ♂ ♂ (6) ex *Onychomys leucogaster melanophrys* Merriam

Monopsyllus wagneri wagneri (Baker)

2 ♀ ♀ (5), 6 ♀ ♀ 3 ♂ ♂ (25), 2 ♀ ♀ (5) ex *Peromyscus maniculatus sonoriensis* (LeConte)
2 ♀ ♀ (25) ex *Reithrodontomys megalotis megalotis* (Baird)
1 ♂ (18), 1 ♀ (5), 3 ♀ ♀ (25), 1 ♀ (6), 1 ♂ (5) ex *Peromyscus truei truei* (Shufeldt)
1 ♀ (25) ex *Neotoma lepida monstrabilis* Goldman

Orchopeas leucopus (Baker)

1♀ (5) ex *Reithrodontomys megalotis megalotis* (Baird)
1♂ (3) ex *Peromyscus crinitus stephensi* Mearns
4♀♀(13), 3♀♀(24), 2♀♀(28), 22♀♀18♂♂(23), 3♀♀3♂♂(31), 2♀♀(1) ex *Peromyscus eremicus eremicus* (Baird)
2♀♀2♂♂(6), 1♀(6) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1♀2♂♂(22), 2♂♂(26) ex *Peromyscus boylii utahensis* Durrant
1♀(20), 1♀1♂(22), 3♀♀1♂(8), 1♂(18), 3♀♀(21), 5♀♀2♂♂(25), 9♀♀1♂(6), 2♂♂(28), 9♀♀6♂♂(5), 1♀(6) ex *Peromyscus truei truei* (Shufeldt)
1♀1♂(23) ex *Neotoma lepida monstrabilis* Goldman

Orchopeas sexdentatus agilis (Rothschild)

1♀(16), 1♀(28) ex *Peromyscus crinitus stephensi* Mearns
1♀(2), 1♀(4), 2♀♀2♂♂(11), 4♂♂(12), 1♀(16), 1♀(24) ex *Peromyscus eremicus eremicus* (Baird)
4♀♀2♂♂(25) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1♀(4), 1♂(2), 1♀(5), 1♀(14), 2♀♀3♂♂(15), 13♀♀5♂♂(11), 4♀♀6♂♂(12), 2♀♀(26), 16♀♀20♂♂(27), 21♀♀11♂♂(1), 27♀♀22♂♂(23), 1♀3♂♂(5), 15♀♀8♂♂(28), 3♂♂(31), 1♂(34), 2♀♀2♂♂(13), 2♀♀3♂♂(15), 1♂(3), 10♀♀11♂♂(11), 4♀♀4♂♂(15), 2♀♀2♂♂(20), 1♀(7), 1♀(25), 6♀♀3♂♂(24) ex *Neotomo lepida monstrabilis* Goldman

Diamanus montanus (Baker)

2♀♀1♂(6) ex *Citellus variegatus grammurus* (Say)

Thrassis bacchi consimilis Stark

11♀♀4♂♂(27), 21♀♀15♂♂(24) ex *Citellus leucurus leucurus* (Merriam)

Thrassis arizonensis littoris (Jordan)

1♀2♂♂(1), 8♀♀9♂♂(11), 5♀♀4♂♂(15), 1♀2♂♂(23) ex *Citellus leucurus leucurus* (Merriam)
1♂(15) ex *Peromyscus eremicus eremicus* (Baird)

Thrassis aridis hoffmani (Hubbard)

1♀(13), 6♀♀1♂(1), 1♂(15), 10♀♀4♂♂(16), 2♀♀1♂(11), 2♀♀2♂♂(10), 1♀(11) ex *Dipodomys merriami merriami* Mearns
1♀(11), 2♀♀1♂(10) ex *Dipodomys deserti deserti* Stephens
4♀♀3♂♂(16) ex *Onychomys torridus longicaudus* Merriam

Thrassis setosis Prince

20♀♀11♂♂(20), 7♀♀21♂♂(4), 2♀♀(13), 18♀♀6♂♂(18), 15♀♀5♂♂(11), 7♀♀5♂♂(15), 12♀♀4♂♂(3), 1♀(24), 1♀(32) ex *Citellus leucurus leucurus* (Merriam)
1♀(2) ex *Thomomys bottae nicholi* Goldman
1♂(19) 1♂(23) ex *Dipodomys merriami merriami* Mearns
1♀(6), 2♂♂(24) ex *Onychomys leucogaster melanophrys* Merriam
1♀(23) ex *Onychomys torridus longicaudus* Merriam
1♀(5) ex *Reithrodontomys megatotis megatotis* (Baird)
1♀(28) ex *Peromyscus eremicus eremicus* (Baird)
1♀(28), 1♀(3) ex *Neotoma lepida monstrabilis* Goldman

Dactylopsylla bluei psilos Prince and Stark

1♀(24) ex *Thomomys bottae nicholi* Goldman

Dactylopsylla ignota utahensis (Wagner)

1 ♀ 3 ♂ ♂ (9), 2 ♂ ♂ (6) ex *Thomomys bottae nicholi* Goldman
12 ♀ ♀ 18 ♂ ♂ (8) ex *Thomomys bottae planirostris* Burt
1 ♀ (25) ex *Thomomys bottae trumbullensis* Hall and Davis
1 ♀ (5) ex *Peromyscus boylii utahensis* Durant

Peromyscopsylla ebrighti (C. Fox)

1 ♂ (7) ex *Reithrodontomys megalotis megalotis* (Baird)
4 ♀ ♀ 3 ♂ ♂ (16), 1 ♀ (3), 1 ♀ 3 ♂ ♂ (11), 3 ♀ ♀ (10) ex *Peromyscus crinitus stephensi* Mearns
2 ♀ ♀ 1 ♂ (3), 8 ♀ ♀ 4 ♂ ♂ (11) ex *Peromyscus eremicus eremicus* (Baird)
1 ♂ (6) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1 ♀ (3), 2 ♂ ♂ 1 ♀ (6) ex *Peromyscus truei utahensis* Durrant
1 ♂ (11) ex *Neotoma lepida monstrabilis* Goldman
(Note: verified by Dr. Phyllis T. Johnson. The senior author has also taken this species from Madera County, California.)

Peromyscopsylla hesperomys adelpha (Rothschild)

1 ♂ (9), 1 ♀ (6) ex *Onychomys leucogaster rudiosae* Stone and Rohn
1 ♂ (7) ex *Reithrodontomys megalotis megalotis* (Baird)
2 ♀ ♀ (21), 2 ♂ ♂ (1) ex *Peromyscus crinitus stephensi* Mearns
2 ♀ ♀ 1 ♂ (4), 1 ♂ (1) ex *Peromyscus eremicus eremicus* (Baird)
2 ♀ ♀ (5), 1 ♂ (7), 2 ♀ ♀ (3) ex *Peromyscus maniculatus sonoriensis* (LeConte)
1 ♀ (20), 4 ♀ ♀ (18), 1 ♂ (21) ex *Peromyscus truei truei* (Shufeldt)

Sternistomera alpina (Baker)

9 ♀ ♀ 6 ♂ ♂ (5) ex *Neotoma lepida monstrabilis* Goldman

Miochaeta macrodactyla (Good)

2 ♀ ♀ (21) ex *Peromyscus crinitus stephensi* Mearns

FAMILY PULICIDAE

Cediopsylla inqualis interrupta Jordan

1 ♀ 3 ♂ ♂ (1) ex *Urocyon cinereoargenteus scottii* Mearns
1 ♀ (30) ex *Citellus leucurus leucurus* (Merriam)
1 ♀ (32) ex *Peromyscus crinitus stephensi* Mearns
65 ♀ ♀ 65 ♂ ♂ (24) ex *Sylvilagus auduboni arizonae* (Allen)

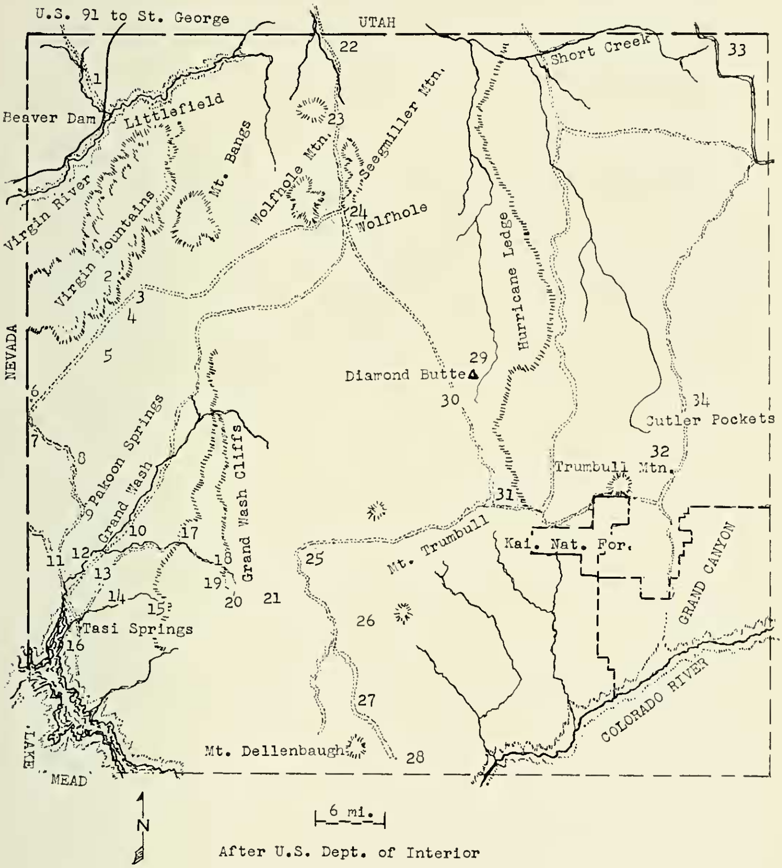
Hoplopsyllus anomalus (Baker)

1 ♀ (2), 18 ♀ ♀ 6 ♂ ♂ (30) ex *Citellus leucurus leucurus* (Merriam)
1 ♀ (24) ex *Onychomys leucogaster melanophrys* (Merriam)

Hoplopsyllus glacialis affinis (Baker)

4 ♀ ♀ 1 ♂ (30) ex *Sylvilagus auduboni arizonae* (Allen)

Thirty-five (35) species of fleas are reported. These representing twenty-one (21) genera and three (3) families. The known distributional range of many species have been extended.



After U.S. Dept. of Interior

PLATE 25

PELECYPHORUS RECORDS FROM SOUTHWESTERN UNITED STATES WITH DESCRIPTION OF TWO NEW SPECIES

(Notes on North American Coleoptera, No. 16)

By CHARLES S. PAPP

The Tenebrionid genus *Pelecyphorus* was erected by Solier (1836). Specimens with the same taxonomic characters were later named by Lacordaire (1859) as *Philolithus*. Horn (1870) included Solier's generic name as synonym to *Asida* Latreille (1804) with another genus *Euschides* LeConte (1858, not 1851). Only *Philolithus* is a synonym of *Pelecyphorus*, all the others represent species with excellent generic characters and as such they are accepted as valid names (Papp 1961).

There are several old species of this genus discussed with descriptions of several new ones in Horn's paper (1870). The discovery of *Pelecyphorus actuosus* Horn in stored chicken feed from the Mojave Desert (Quartz Hill area) was reported by Papp and Pierce (1960). These specimens have recently been compared with specimens obtained from the type locality of *P. actuosus* and are now considered as a new species. Another new species from the lower portion of the Mojave Desert will also be described.

Pelecyphorus actuosus Horn 1870 (Trans. Amer. Philos. Soc. 14:284). Type locality Owen's Valley, California, collected by Horn and by Cronkhite. See Plate 26, fig. A-C. — Specimens from the Bishop area, collected by the late George P. Mackenzie, August 29th, 1946, average 19.0-22.0 mm in length. There are little differences between male and female; however females usually are broader. I have seen smaller females and larger males from the same locality. *Pelecyphorus actuosus* Horn, is one of the early Californian species. In the original description Horn observed an obsolete costa, which I could not observe on any specimens seen from this area. The costae are moderately prominent and reaching to the end of the elytra where they appear to be nearly united from the dorsal view, but clearly separated if seen from the anal view. The third costa between the sutura and the second costa is broken but still visible and slightly shorter than costa one and two (Fig. B, C). The costae are all shiny, smoothly curved longitudinally. The surface of elytra is opaque. The fine granules are sharply elevated and appear to be smooth.

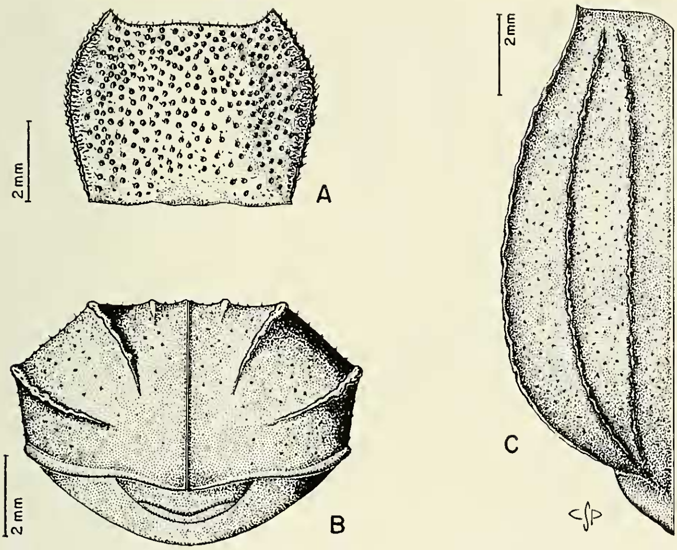


PLATE 26
Pelecyhorus actuosus Horn

Pelecyphorus jaegeri Papp, new species (Plate 27, A-C). — Locality: Quartz Hills, eight miles north of Palmdale, in the Upper Mojave Desert, Los Angeles County, southern California. — Black. Large, males 19.0-21.0 mm., females 20.0-23.0 mm. Head, pronotum, anterior legs opaque, the rest of the body, especially the strongly elevated elytra are smooth and shiny.—Head finely granulated, each granule with very short setae. Vertex flat, squarely impressed; labium widely rounded, anterior margin with dense, blackish-brown short setae. Labial palpi strong, last joint about twice as long as the second, triangularly shaped, smooth, on the exterior margin with short semi-erect setae. Antennae black. — Pronotum (A) slightly wider than the length, anterior margin longer than the posterior, sides more or less sharply rounded, margin heavily crenulated; edges sharp, pointed, in the anterior cornel with one more or less well visible rounded depression. Surface in the middle roundly elevated, near posterior end, occasionally also along the middle, with a smoother line; this surface very finely punctulate, occasionally with few heavier punctures. The anterior margin always with short, brownish-golden hairs. — Elytra (B, C) smooth, shiny. Margin rounded and less elevated than any of the longitudinal costae. The surface between the elytral margin

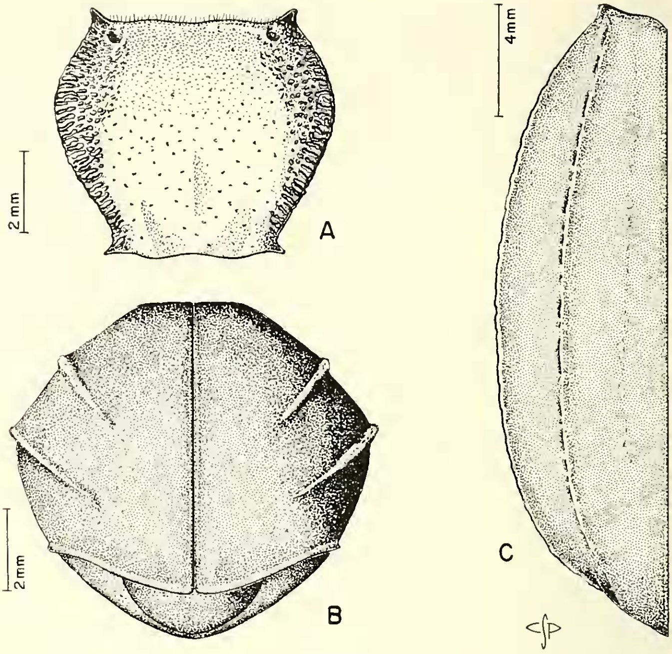


PLATE 27
Pelecyphorus jaegerni n. sp.

and the outer costa slightly concave, that between the outer and second costae flat; the surface between the latter and the sutura somewhat broken (B), well visible posteriorly. Humerus sharp, slightly pointed (C); a third costa near the sutura, as a shallow ridge sometime visible. — Legs heavily crosswise granulated, claws dark brown, otherwise black; anterior pair opaque, others slightly shining; all with very short, dense setae. — Abdomen shiny, smooth, much finer punctured than the middle of the pronotum. — There are externally, except in sizes, no morphological differences in structure between sexes.

This species was previously reported by Papp and Pierce (1960) as *P. actuosus Horn.* It was first found by H. D. Pierce in October 1958, who is now conducting his study on the life history of this species. All ecological notes mentioned on page 156 under *actuosus* are to be added to observations with *P. jaegeri.*

The new species is sincerely dedicated to Dr. Edmund C. Jaeger, distinguished student of the North American deserts.

Pelecyphorus porcatus Papp, new species (Plate 28, A-C). — A single female specimen from Whitewater, Southern California, from the aleolian sand dunes, west of the Joshua Tree National Monument. Length 22.0 mm. This extremely large, black species can easily be recognized by the sharp second costa, the deeply set middle portion of the elytra, and the comparatively small pronotum (A). — HEAD slightly wider than long; the surface with sharp, deep punctures; vertex flat and not separated; labium slightly annulated in the middle; the margin above and beneath the eyes with well developed and somewhat pointed sharp cornels. Antennae deep dark brown, nearly as long as the head. — PRONOTUM small (A), wider than long, anterior margin slightly shorter than the posterior, anterior tip sharply pronounced, sides behind middle wider and more roughly edged as nearing the middle, posterior tips less pronounced, weakly pointed. Surface with fairly large rounded punctures evenly punctuated, middle sharply concave, edges almost flat, the latter with more dense granulation. The edges of the anterior of posterior portions of the pronotum are roughly parallel. — ELYTRA (B, C) in size very large compared with the pronotum, its margin shallow and smooth (B), the first

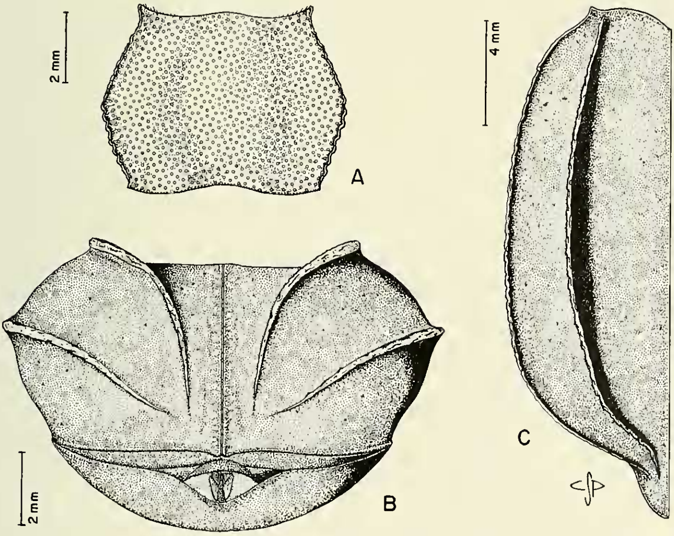


PLATE 28
Pelecyphorus porcatus n. sp.

costa gradually elevated, the surface between the edge and the first costa, and between the first and the second costae similarly convex; that between the second costa and the sutura deeply set and flat (B); the second costa in its inner side sharply, in its outer side gradually elevated (B, C). The surface very finely and densely punctured with small and occasionally larger punctures; the middle slightly inpressed, and smoothly wrinkled near the suture (C). The shoulders sharply pointed; the anal end narrow and more pointed compared with the previous species. — Legs, only one right middle and hind left legs are present; they are roughly granulated, the spaces between granules smooth, almost shining. — Abdomen evenly and sparsely punctured, these punctures slightly finer than those of the pronotum.

The specimen was collected by Dr. A. L. Melander, on October 27th, 1934, and as type specimen it is now in the collection of the Department of Biological Control, Citrus Experiment Station, Riverside, California. Thanks are given to Prof. P. H. Timberlake for loaning *Pelecyphorus* material for examination.

Pelecyphorus carinatus LeConte (1851) briefly mentioned by Horn (1870: 285) and referred to the illustrations of Lacordaire (1859) and quote only the type locality San Felipe, California. The Department of Entomology, Citrus Experiment Station, Riverside, Calif. has three specimens in the late George P. Mackenzie collection, collected by Mackenzie in Borrego, southern California, on October 7th, 1939. An additional specimen from the same location is in the author's collection. — This species is easily distinguished by its opaque but smooth general appearance, the short distance between the two costae, and the sharply, triangularly elevated middle portion of the pronotum. This interesting species will be discussed in detail in another paper with a group having similarly composed form of the pronotum.

Pelecyphorus adversus Casey (1912), a roughly built species with two very prominent costae. There are two specimens in the Mackenzie Collection from Phoenix, Arizona, collected by G. P. Mackenzie on October 7th, 1939. The author also has one specimen from Phoenix, Arizona, and one from Wickenburg, Arizona.

Pelecyphorus opinus Casey (1912). Two specimens from Muroc, California, collected by G. P. Mackenzie, on September 15th, 1944, are in the collection of the Department of Entomology, Riverside.

Pelecyphorus morbillosus LeConte (1858) represented by two specimens from Gila Bend, Arizona, collected by F. H. Parker, on September 13th, 1935. Also known from Sonora and Lower California. Pallister (1954) has previously discussed the restricted distribution of this remarkable species.